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Ultimate Boiler Capacity Limited by Stoker Conditions*

Size and Distribution of Air Openings Through Grates—Forced Draft Required to Overcome Resistance in Fuel Bed—Formation of Clinker Influenced by Character of Coal and Other Factors

By JOSEPH HARRINGTON

Vice-President and Engineer, James A. Brady Foundry Co., Chicago.

As indicated in the previous articles of this series, it is almost impossible to separate the stoker and its fuel in any discussion of limiting conditions. What one stoker will do with a certain fuel is no indication of what another will do; and, given a certain type of stoker, it is well known that some coals will produce impossible furnace conditions. We see, therefore, that what happens in the furnace is the result or product of fuel characteristics, multiplied by the action of the stoker as it affects the fuel.

*Fourth and last of a series of articles by Mr. Harrington, assisted by W. A. Nelson, advisory engineer of the James A. Brady Foundry Co., dealing with the present fuel situation from a combustion standpoint. Previous articles of the series appeared in the Oct. 16, Nov. 20, 1920, and Jan. 22, 1921, issues of Electrical Review.

In the previous article the tendency of very fine coal to produce the following three results has been covered: First, blowing clear out of the fuel bed and into the combustion chamber or boiler setting; second, the leakage or sifting through the air spaces of the grate, and, third, the restriction to the flow of air caused by the density of the fuel bed. It is a direct logical step, therefore, to conclude that to develop capacities the stoker must provide offsetting conditions that will neutralize these tendencies in the fuel itself.

If a stoker providing localized air inlet at high velocity is supplied with a coal containing a percentage of light fine material, we have every con-

View of Boiler Room of Cleveland Illuminating Co., Showing Three of the 18 Harrington Stokers Installed.

dition necessary for blowing holes in the fire and providing excess air. The conclusion is unescapeable, that the stoker should have the maximum amount of distribution in its air openings. That is, the air openings should be as generally and as uniformly distributed as possible so that there may be no concentration of blast upon any one point in the fuel bed.

The second objectionable condition produced by fine fuel is similarly answered by saying that the stoker should (while providing all of the necessary air space in its grate surface) not have direct openings through it which will permit of the finer part of the coal sifting through. Without doubt capacity is limited to a very marked extent by the manner of introducing the air. It is a case primarily of air velocity, so that to offset the fine coal conditions the velocity of the entering air must be held down to a point where it will not bore holes in the fuel.

The third limitation, that of blanketing or packing so tightly as to simply exclude the air from the furnace, can only be overcome by raising the pressure under the fuel bed by artificial means to an extent sufficient to cause penetration. Natural-draft stokers are, therefore, directly limited in their coal-burning capacity by the resistance of the fuel bed. If this is greater than can be overcome by the furnace draft the limit has been reached.

Air Spaces Reduced to Minimum With Mechanical Stokers.

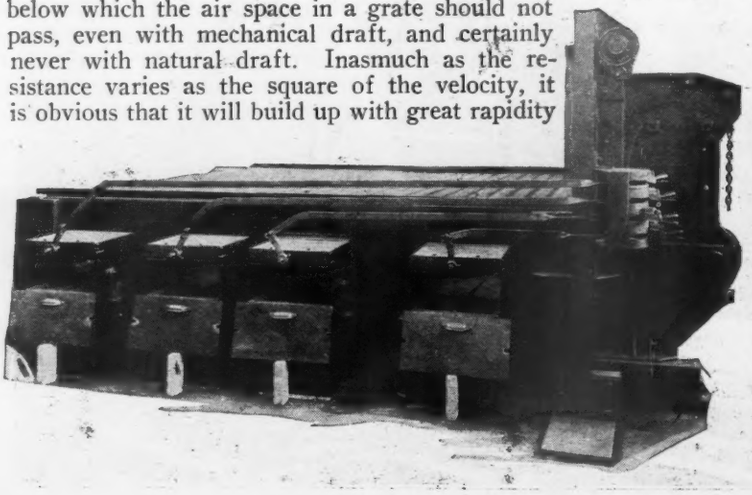
Even with artificial-draft equipment the resistance offered by the grate surface itself is a thing to be considered. In the old days when hand-firing was the rule it was considered necessary to have 50% air space in the grate surface, but as stokers began to be developed 50% was found to be obviously excessive, and due to the movement of the grate surface tending to cause the air spaces to keep clean sifting became excessive. The air space was then reduced more and more. It has been my experience that at ordinary draft pressures the velocity of the air in and through the average grate surface is not sufficient to build up a restriction that would affect the amount of coal burned per unit of time. Not until the air space was reduced to 10% did it become apparent that there was a lessened rate of combustion for a given draft. I believe, therefore, that this is a critical point below which the air space in a grate should not pass, even with mechanical draft, and certainly never with natural draft. Inasmuch as the resistance varies as the square of the velocity, it is obvious that it will build up with great rapidity as soon as the restriction becomes at all pronounced.

Another condition which engineers will note as effecting ultimate capacity is the lack of uniformity in the distribution of the fuel on the grate surface, and the presence of short-circuits therein. In the traveling-grate stoker a clinker attached to the side walls near the front will plow off the coal at the sides, and there will quickly develop a streak of bare grate nearly the full length of the stoker at either side. With any kind of draft the air all tends to go through this short-circuit, and much of it does. It seems at times as though the greater the air pressure, the greater also the amount of dilution. If the air spaces in the grate are large this becomes exceedingly pronounced. If, however, the air spaces are of moderate extent, and the stoker is of the forced-blast type, the grate surface offers sufficient restriction to permit air pressures building up under the grate surface to such an extent that it will penetrate the center or thick portion of the fire, and thereby, to a certain extent, effect combustion. Obviously, however, this is done at a sacrifice.

Fuel Bed Tapering to the Rear Introduces Special Problem.

A parallel case to this is where the fuel bed is thin at the rear end, instead of along the sides. Wherever the air is allowed to take its natural course it will flow through this end of the fire, and capacity (if it can be attained at all) is only secured at the sacrifice of efficiency. We have therefore, again, the deduction that the stoker must provide offsetting conditions. These may be restated briefly as providing a perfect uniformity in the distribution of the coal on the grate surface, and a controllable presentation of the air in such a manner that the direct short-circuiting through thin spots can be definitely avoided. The next proposition of interest, and one which will claim the attention of every one having to do with mechanical stoking, is the limitation to capacity imposed by the melting of the ash.

Ash will melt at temperatures from 2000 to 27000 deg. F., and it is the exceptional case, involved only at very low rates of combustion, wherein the actual temperature in the fuel bed is not in excess of 2000 deg. F. We have, therefore, conditions which, in many cases, provide of necessity the requirements for melting the ash.



Side View of Harrington Stoker Showing Air-Control Equipment.

Even though actual liquification does not take place the ash reaches a sticky condition several hundred degrees below the point of actual melting, so that should two adjacent particles of ash come into actual contact they will blend and form a larger piece. If the stoker be of such type that the fuel bed is constantly agitated it is obviously impossible for these particles to travel through the fire without coming into contact. The unavoidable result is a clinker, and the size of the clinker depends upon the amount of ash and the amount of stirring or mixing to which the ash is subjected.

However, if a layer of coal is left undisturbed and supplied with air from the underside, the ash forms first on the side of the entering air, and gradually builds up until combustion is completed. It is obvious that the air supplying the oxygen for the combustion of the second inch of fuel must pass through the ash produced by the combustion of the first inch, keeping it cool, maintaining its porosity, and preventing its fusion. The heat generated by this combustion is carried away from the ash layer into the furnace, and if the fuel is not disturbed it will gradually burn up to a porous ash bed formed of a series of small particles, each one representing a piece of coal in the original fuel bed. This ash, when thus produced, can be handled conveniently by any suitable conveyor, and will not have the intermixture of coke and hard clinker which characterizes the ash from some types of stoker.

Formation of Clinker Influenced by Fuel and Stoker.

I do not need to enlarge upon the statement that the clinkers formed by such a fuel-bed disturbance may actually be of sufficient extent to completely cover the grate surface. Only in the most extreme cases, such as when washer refuse is used, is there a clinker formed on the undisturbed fuel surface of sufficient extent and density to affect the combustion of the coal. With washer refuse, which contains perhaps 50% of ash, it is quite possible, when burned in a furnace which attains high temperatures, to fuse it into a continuous pancake clinker; and this is the reason for the statement in the previous article that such fuel should be burned at rates of combustion of not over 25 lbs. per sq. ft. per hr. This does not produce temperatures which will melt the ash.

A detail of stoker design which seems almost too obvious to require explanatory description is, nevertheless, in certain cases, the factor which controls the amount of combustion possible. In all but selected classes of coals there is contained a certain amount of sulphur and a high percentage of ash. When such an ash liquifies it drops onto the grate surface and may drip down through the air spaces therein. It will adhere rather tightly to the grate bars, and to a certain extent, close up the air spaces between them. The ash thus dripping down from any one fuel bed is seldom enough to seriously affect the amount of air space, but if repeated will eventually close it up. If, however, the stoker is of such type that the air spaces are automatically cleaned by virtue of the relative motion of adjacent parts, at frequently recurring intervals, the clinker is cleared out and the full amount of air space is maintained. With any coal having a tendency to produce a liquid clinker this requirement is an absolute essential if maximum capacities are to be maintained. If such cleanliness of air space is not automatically maintained the amount of coal that can be burned gradually decreases as the air space is cut down, until sooner or later the grate surface will overheat and burn out, necessitating complete replacement.

We have therefore, in conclusion, certain fundamentals of stoker design necessary for maximum continuous capacity, which I will briefly restate: First, a self-cleaning air space of at least 10%; second, a uniformly distributed air space to prevent localization of blast; third, a grate surface that will not permit the fines running through the openings provided for the admission of air; fourth, a stoker which provides means for mechanical air supply at such places and at such pressures as may be required by the condition of the fuel bed throughout its successive changes from ignition to ash; fifth, the stoker must provide a perfectly uniform and continuous distribution of coal to avoid the short-circuiting which occurs when holes are present, and sixth, the fuel bed must remain quiet to prevent the formation of clinkers whenever rates of combustion are such as to provide melting temperatures within the fuel bed.

HAZARDS OF FAULTY SWITCHBOARD CONSTRUCTION.

Equipment Must Be Suitable to the Character of Service Demanded—Paper Presented Before Illinois State Electric Association.

By Roscoe M. Bert,

Electrical Superintendent, Rockford (Ill.) Electric Co.

Few of us realize the hazards that exist in our power plants due to faulty switchboards. In the rapid growth of stations during the past few years the safety of switching equipment has often been overlooked. There are many power plants in operation all over the country, with switchboards for 2300 and 4000-volt systems, which are entirely inadequate to properly perform the true function of a switchboard in case of an emergency. This unsafe condition has been brought about, first, by lack of engineering information regarding capacity of switches and the enormity of short-circuit currents on large generators, and, second, by power-plant owners being unable to secure the money to install switching equipment in keeping with the growth in plant capacity.

Regarding engineering information, there is now available considerable data that makes possible a reasonably safe switchboard under all conditions of short-circuited cables and busbars. To obtain proper safety the following points must be carefully considered: (1) Ultimate capacity of generators installed; (2) reactance of generators when all are operated in parallel; (3) proper location of external reactance to limit short-circuit currents; (4) selection of an oil switch which will open the circuit under the worst possible conditions, and (5) proper arrangement of the apparatus to reduce life and fire hazards.

Every power plant has its individual problems that should be gone into very carefully with expert engineers and with manufacturers of equip-

ment. It is not intended to enter into these details but to describe and point out present dangers and some of the remedies, especially considering stations that are operating switching equipment which is inadequate to meet an emergency. In many cases the point has been overlooked that any switch connected to a main busbar should have a rupturing capacity equal to the total short-circuit capacity of all generators in operation, or should be protected by reactors to within the limit of the rupturing capacity of the switch and, of course, should be protected by dependable relays.

Accident Resulting From Failure to Provide Larger Switches.

In the past few years many stations of comparatively small capacity have made additions of large generators and connected them to the existing switching equipment, and in many cases have "gotten by" with no serious results. But in other stations serious fires and accidents have occurred. As long as service is satisfactory, and until an accident occurs, we do not realize the dangers that exist. Just recently this was very forcibly brought to attention at a property in Indiana. In this instance an oil switch short-circuited and blew up, killing two men and destroying by fire half the bus structure and a quantity of cable and damaging several motor-generator sets. Property damages amounted to approximately $40,000. Had the repair men and operator realized the danger and had sufficient fear of results, the loss of life and most of the property damage could have been avoided.

The station capacity in this particular case is about 20,000 kw., the largest unit being rated at 10,000 kw. This is one of the cases referred to above where the old switching equipment was retained and large machines added to the plant. The switchboard proper is located on the main floor with the bus structure in the basement. The switches are mounted in the usual brick and concrete compartments, and the busses are mounted about 4 ft. above the cells and spaced about 8 ins. between centers with no compartments or barriers and are completely taped up with cambric and friction tape. This taping was done to protect men while working in the switchroom, but increased the fire hazard to a considerable extent by adding to the combustible material.

At the time of the accident one 10,000-kw. turbine was in operation and a 4000-kw. unit was being synchronized. The switchboard operator had pulled the closing button three times and the solenoid-operated switch failed to remain closed. He reported the condition to the station electrician who entered the switchroom below with a helper. The turbine switch had been blown open and oil was on the floor, and there was some fire in the switch compartment. The electrician and helper proceeded to pump pyrene onto the fire. In a few minutes there was a violent short-circuit and an explosion of burning oil which saturated the clothing of the two men. The station electrician was an experienced man, but in his effort to save the plant and avoid an interruption of service he did not realize the hazard of fighting such a fire.

It now develops that the proper thing to have done was to immediately shut down the entire plant when the defective switch and fire were first discovered. In Rockford, with a similar layout of switches, we have had such fires start, but no one had the nerve to fight the flame until power was shut off. The writer would advise all operators to instruct their men to refrain from making any attempt to fight such fires on live switches or other apparatus.

After this first explosion in the switch there were two or three other short-circuits, and half of the bus structure was completely destroyed. All insulating material of a combustible nature was completely consumed, and flames came up from all openings and destroyed other valuable apparatus. By the combined efforts of the entire organization service was resumed again at 5:30 p.m., the accident occurring at 7:30 in the morning. This property was fortunate in having a double set of busses, only half of them being completely destroyed. Had there been only one set the duration of the interruption, no doubt, would have been several days. As a result of this accident our engineers have decided to completely rebuild the switching equipment of the Rockford property and all others which are in an unsafe condition. All switches and busbars will be placed out of doors, using weatherproof apparatus completely. This has been done for some years for high-voltage equipment of 13,000 volts and above; so why not for 2300 and 4000-volt systems? The details of this scheme have not been fully worked out, but we have consulted manufacturing engineers and they think the proposition feasible. This layout, we are sure, will greatly reduce the possibility of fire and will make a safer proposition for the men to operate and keep in repair.

All Plant Equipment Subject to Failure at Times.

As long as we have power plants we will have accidents, and even the best of switching equipment is not perfect and will fail to function at times. We should, therefore, exercise all care to guard against loss of life and property. When a fire once starts in a high-power switching rig it is extremely unsafe to fight it with the power supply connected. From our recent experience we say: Shut down immediately, then put out the fire, disconnect defective apparatus and resume service. A half hour's interruption is better than taking a hopeless chance.

Frequently switchrooms are partitioned off from all other parts of the power house and are seldom seen by the operators. It would seem advisable that openings be provided, if possible, so that any start of fire could be promptly seen by the station men. These openings should serve a further purpose to allow men to escape in case a fire starts while they are working on the apparatus in these compartments. All switches should be frequently inspected and the oil changed as often as the rupturing capacity of a switch is greatly reduced. Operators should be cautioned about the accurate synchronizing of generators, as this imposes severe service on switches unless done accurately. To improve this accuracy it is recommended that a synchroscope with a very large dial be used, and that station men take plenty of time to put machines on the lines correctly.

There are plants of considerable capacity where no synchronizing instrument was used, the operators depending entirely on the old lamp scheme, an extremely careless practice.

Transformer-Vault Location, Construction and Equipment

Hazards to Be Guarded Against—Fireproofing in Various Cases —Cooling and Ventilation Important Factors in Safe Practice —Paper Before Western Association of Electrical Inspectors

By H. J. CLARK

Engineer, Oklahoma Inspection Bureau, Oklahoma City, Okla.

Oil-cooled transformers have always been considered a distinct fire hazard by insurance interests, and recommendations in general have asked for the elimination of these devices from the inside of buildings. In the great majority of installations, because of the relatively small amount of power required, the distribution of electrical service by overhead transmission lines, and the moderate voltage used, it has generally been practicable to install the transformers on poles or platforms on the outside of buildings.

With the development of the large electric power plant, followed by cheaper rates, there has been a great demand for electric power by manufacturers, particularly in the larger cities. Often very large quantities of power are used by single consumers, necessitating the installation of electrical equipment approaching in size that of fair-sized substations. In congested districts distribution is now largely underground, and operating companies have found it practicable to distribute current at very high potential, 6600 and 13,200 volts being not uncommon. Equipment, including the necessary transformers in connection with such services, requires considerable space.

Separate Building Best for Transformer Vaults Where Possible.

Where space permits it is desirable and strongly recommended that a separate building of fire-resistive construction be provided, and in such cases, as there would be no exposure to other property of high value, the structural features of the building such as thickness of walls and roof are of little importance. The size of such buildings must necessarily depend on the bulk of the equipment to be used and the space necessary for insulation, ventilation, accessibility, and in every instance sufficient space for safety to attendants who may enter the building.

In congested districts, where space is not available for detached buildings to house transformers and station equipment, it becomes necessary to house the equipment in buildings used mainly for other purposes. The inspection bureau having jurisdiction should always be consulted before definite installation arrangements are made, mainly for the reason that the installation will often result in changes which will affect the fire hazard and the insurance rates. Although every bureau and practically all municipal departments have established rules governing installation, the bureau engineer can often make suggestions regarding the location and arrangement of the transformer vault or room which will provide added safety; and we cannot go too far in this respect where very large values are involved.

The vault should preferably be located in a portion or division of the plant easily accessible to firemen and, so far as possible, with noninflammable surroundings. If the vault is in a building of fire-resistive construction the top of the vault may be formed by the floor above, if such floor is fireproof. If the floor or roof above is of inflammable material the vault ceiling should preferably be 3 ft. below the floor or joists, and the space left open and accessible.

Present Code Rules More Liberal Than Those of the Past.

The rules regarding transformer installations, as contained in the 1920 edition of the National Electric Code, are more liberal than in previous editions, so that it is not now impracticable to strictly comply with them. The code now permits wires of circuits with potential up to 5000 volts to be brought into buildings, and extra-high potentials—above 5000 volts—may be brought into transformer vaults. The rules governing installation of transformers seem adequate to safeguard the fire hazard of these devices, but it might not be amiss to discuss the provisions as contained in Rule 45.

In Section (a) it is stated that "Transformers must not be placed inside of buildings other than power stations and substations without special permission. They must be located as near as possible to the point at which the primary wires (referring to potential less than 5000 volts) enter the building, and must be placed in an inclosure of fire-resisting material, with an air space of at least 6 ins. on every side." The above is interpreted to refer only to the air-cooled type of transformer. Natural-draft air-cooled transformers are limited in size by common practice and economy to capacities of 5 kw. or smaller with a voltage of 600 or under. The burning out of a transformer of this size and type would not result in a large flame or great amount of heat, and would be sufficiently safeguarded by a tight inclosure equal in fire-resistive qualities to 0.25-in. asbestos board, 22 gage sheet iron, or metal lath and plaster, with incombustible supports. Air-blast transformers are built in larger sizes and for higher voltages, but seldom exceed a capacity of 200 kw. These transformers are generally installed in units of three single-phase or one 3-phase transformer ventilated by a single blower. The larger units have sufficient inflammable material in their construction to generate considerable

heat in case of burn out, and, should the blower be shut down, the fire may communicate to other units if more than one are installed. Adequate protection for the larger installations would be secured by an inclosure equal in fire-resisting qualities to 4-in. tile or gypsum blocks. Section (a) further states: "The inclosure must be securely locked, and access allowed only to authorized persons. It must be thoroughly ventilated, preferably through a chimney or flue to the outside air."

The size of ventilator will depend on the size of the apparatus and the draft conditions. The ambient temperature must be kept below 40 deg. C. Adequate ventilation for inclosures containing natural-draft air-cooled transformers could probably best be secured by placing one or more screened openings in the wall of the inclosure near the floor, not larger than 6 by 12 ins., and placing a ventilator near the top having a size not less than 12 ins. square if opening directly to outside air, but possibly smaller if connected with a flue or chimney having good draft. (b) The transformer case must be permanently and effectively grounded in accordance with rule 15A. (c) Oil-immersed transformers in buildings other than power stations or substations must be inclosed in fireproof vaults constructed as follows:

"(1) The inclosure must consist of concrete not less than 6 ins. in thickness, or of brick not less than 8 ins., except that when the total transformer capacity so inclosed is not over 100 kv-a. the above thickness may be reduced to 4 ins., provided approved fireproof material is employed and the construction of the vault is specifically approved by the inspection department having jurisdiction. Outside walls of the building, if of fireproof construction, should preferably constitute one or more of the walls of the vault or inclosure.

"(2) Transformer vaults or inclosures must be provided with means for ventilation which will prevent the development of room temperatures in excess of those at which the transformers installed therein may be safely operated. Limiting temperatures shall be determined in accordance with and in the manner described by, the standardization rules of the American Institutes of Electrical Engineers, and temperatures under full-load must not exceed the values given in those rules. All ventilating openings not connected to chimneys or flues shall be provided with automatic or manually controlled dampers to prevent the emission of smoke or fire. Damper controls should preferably be arranged to be operated from a point outside of the vault."

At this point it may be noted that the measurement of transformer temperature, as prescribed by the A. I. E. E., is by the resistance method. These rules establish, in general, temperature limits as follows for oil-cooled transformers using fibrous insulations at rated load:

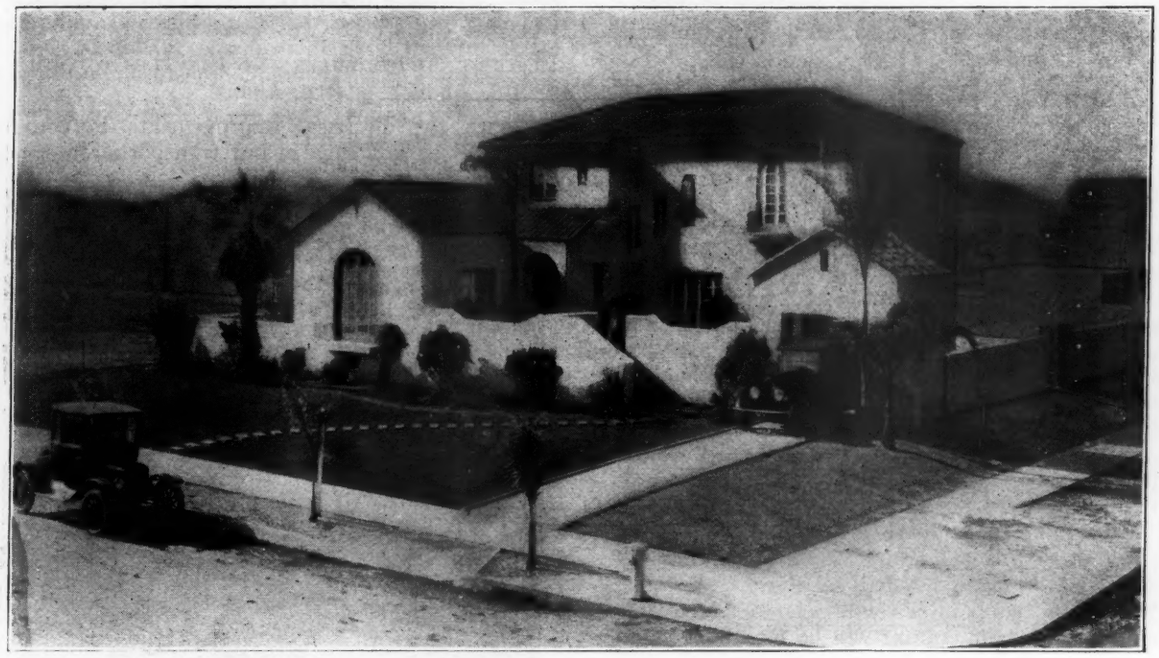
	Deg. C.
Permissible hottest spot temperature	105
Hottest spot correction	10
Limiting observable temperature	95
Ambient temperature	40
Limiting observable temperature rise	55

The temperature rise of a transformer is dependent on losses in the core and windings and many other design features. There are now devices for measuring the hot-spot temperatures, and operating companies can obtain and furnish to consumers transformers of known temperature rating which will meet with this rule. Transformers that will conform to the above requirements will have a temperature of about 40 deg. C. at 75% load, and 30 deg. C. at 50% load. The ventilation then must be sufficient to maintain ambient temperatures not in excess of 40 deg. C. or 104 deg. F. It is impracticable to estimate the size of the ventilating openings necessary to maintain the required temperatures, but it is believed, however, that for equipments of not over 50-kw. capacity two vents connected with the outside air, one near the floor and the other near the ceiling, each having an area of 144 sq. ins., would be ample. For equipment up to 100 kw. 2 sq. ft. to each vent should provide adequate ventilation. The conditions and location of the vault should govern ventilating requirements for the larger sizes. In large units, such as are often used in indoor installations, the oil-insulated transformers are frequently water cooled. The cases of such transformers are cooled, the heat being carried out by the cooling water, hence the ventilating area required would be much less than for types depending on heat radiation from the transformer cases.

"(3) Where practicable, a suitable drain must be provided which will carry off any accumulation of oil or water that may collect in the vault. Floors and drains should have a pitch of not less than 0.25 in. per ft. In vaults containing transformers having a total capacity of 100 kv-a., or less, the drain may be omitted if the inclosure is so constructed as to retain all of the oil within the vault.

"(4) Unless opening is from the outside of the building only, the doorway to the vault must be thoroughly closed by means of an approved tight-fitting fire door. A door sill not less than 4 ins. in height must be provided. In all cases the sill must be of sufficient height to confine within the vault the oil from the largest transformer installed. (d) It is recommended that when oil switches are used to control transformers, such switches be located within the vault or inclosure."

A few words might be said in regard to fire extinguishment in transformer vaults or inclosures. Of course, the first act would be to cut off the power supply from the apparatus. Some favor pole cutouts on the outside of the building, and when these are installed the disconnect should be made at this point. Where the service is connected to an underground distribution system the disconnect must necessarily be inside of the vault, but it should not be necessary for the attendant or fireman to enter the vault for this purpose. It seems to be good practice, and not in violation of the rules of the code, to install electrical or manual-control devices on the outside of the inclosure. After disconnection, fires within the vault should be easily controlled and extinguished by carbon tetrachloride types of extinguishers. Where automatic sprinklers are installed in a building the protection should not be extended into electrical-apparatus rooms containing high potential, except a valve be installed in the line controlling sprinklers in the vault and the valve be kept closed except in case of fire, when water must not be turned on until the power is cut off. Instructions should be posted on a card attached to the valve.



The Adobe Home Electrical in Los Angeles, Cal., Known as "The House Without a Chimney."

Forecasting Great Developments in Electricity

Expansion of Central-Station Practice Predicted by Steinmetz —Elimination of Smoke and Greatly Reduced Power-Costs, as Well as Furnaceless Homes Promised for Realization in Future

By C. D. WAGONER

Publicity Bureau, General Electric Co., Schenectady, N. Y.

The coalless cities and the furnaceless homes often spoken of, but generally referred to as a dream of the scientists, are coming in the very near future, according to Dr. Charles P. Steinmetz, chief consulting engineer of the General Electric Co.

Cooking and heating by electricity is nothing new. Nor is the electrifying of railroads, nor the operating of factory plants by electricity. But just at present the cost of electricity is too high to entirely revolutionize all our domestic life. However, Dr. Steinmetz predicts the day when electricity will be so cheap that it will be universally used, when the government will not allow fires of any kind within the city limits because they are dangerous, dirty and insanitary; dangerous because of conflagrations, dirty because of handling the coal and ashes, and insanitary because of the smoke and gases in the air.

No fires will mean no furnaces in the cellar, no ranges in the kitchen, and no steam power plants. When we use nothing but electrical power for heating, lighting and other purposes the supply will come over transmission lines from big central stations of many million horsepower. These stations will be located wherever power is available, such as at waterfalls, coal mines and oil and gas wells. This will eliminate the wasteful process of hauling coal from the mines to the small power houses now scattered all over the country.

Consider the enormous loss sustained every year by not utilizing coal to the greatest possible extent. Think of the enormous amount of coal used in the United States in the course of a year. In 1918 the consumption was 857,000,000 tons, which may not mean much to the average person until illustrated by the following picturesque comparison by Dr. Steinmetz:

Present Method of Using Fuel Considered Wasteful.

"One of the wonders of the world is the great Chinese wall, running across China for hundreds of miles, by which that country unsuccessfully tried to protect its northern border from invasion. Using the coal produced in one year as building material we could build with it a wall like the Chinese wall around the United States, a distance not of hundreds but of thousands of miles. And the coal produced the next year would represent chemical energy sufficient to lift this entire wall into space for a height of 200 mi.

"Our present method of utilizing coal is inefficient. In converting it into electricity we

throw away about 80% of the chemical energy as heat. At the same time we burn many millions of tons of coal for heat energy, and in this process waste the 20% high-potential energy. It seems an economical crime to burn coal for mere heating without first taking out as much high-grade energy, mechanical or electrical, as is economically feasible."

All these steps tend toward cheaper electricity. Startling will be the changes when this time comes. At present when we want to keep warm on a cold day we use a furnace, kitchen range, the fireplace and other unsatisfactory and insanitary methods. In the summer when the temperature is above normal we are practically helpless and have to suffer. Electric fans give some relief. The coal furnace fire is a source of trouble on cold days, and the heat energy is hard to control. It takes time and attention to keep the fires regulated.

"But when heating is all done electrically," says Dr. Steinmetz, "and I want a temperature of 70 deg. in my home, I shall set the thermostat at 70 and the temperature will not rise above that point. This temperature will be maintained uniformly regardless of the weather outside. This will also hold true on the warm day when the temperature outside may be 90 or 100 deg. The same electrical apparatus will cool the air, and what's more, it will also keep the humidity normal at all times.

"Then, too, there is ventilation which does not exist in the average home today. At present we have to depend on windows, doorways and electric fans to blow the bad air out, and with it we lose in winter most of the heat we produced in our furnaces. When electricity is developed we will have an apparatus for bringing fresh air into the house destroying the bad air and recovering the heat from the warm exhaust air.

General Use of Electricity Predicted for Cooking.

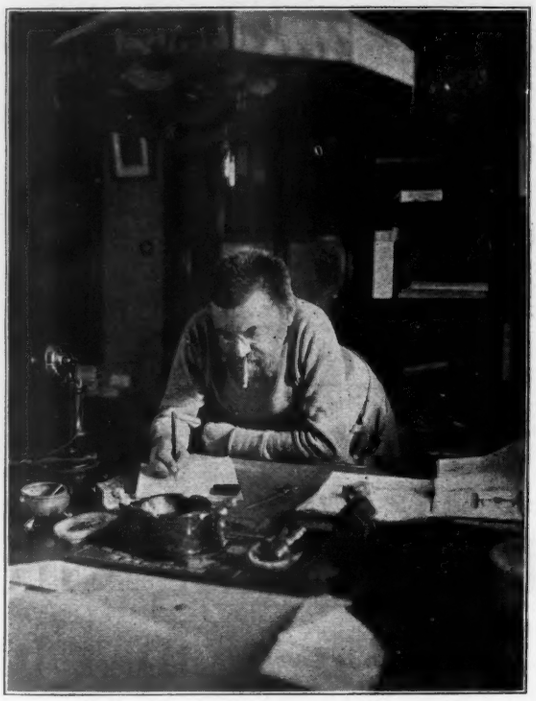
"Cooking by electricity will also be much more satisfactory. There will be no more coal ranges, and a great deal of our food can be cooked on the table. This can also be automatically regulated. For example, we want to cook a cake. We know this should be done at a heat of 230 deg. F. for a period of 45 min., so we set the regulator at 230-45 and cease to worry. At the expiration of 45 min. the heat will be automatically turned off.

"Entertainment in our homes will also be improved. There will be no need to go to some congested poorly ventilated hall for a musical concert. We just push a plug into a base receptacle, as we do for the vacuum cleaner or table lamp, and we can have the concert brought into our homes. Music will be supplied by a central station and distributed to subscribers by wire, just as we get our telephone service today. Perhaps this may be by wireless, the home being equipped by a radio receiving apparatus. With this arrangement improved we may hear grand opera stars as they sing in European capitals while sitting in our libraries at home.

"The most essential purpose of the cellar today is a satisfactory place to house the heating furnace, the coal supply and ashes. With the 'Home Electrical' these two purposes, as well as many others of lesser importance, are eliminated. So what use can we put this space to?

Electric Automobiles and Bicycles to Come Into Use.

"With the electrical improvements to come there will be a change in our transportation system. There will be more electric automobiles and electric bicycles and tricycles will be developed. Because of their simplicity and low price they will be available to almost every one," predicts Dr. Steinmetz. "Our cellars will be the place to keep them. We will have driveways going under the house. This will eliminate the need for garages which many times mar the beauty of the landscape of the property. While the cars are in the basement they will have their batteries recharged.



Dr. C. P. Steinmetz at Work at His Desk.

"Electricity will be used so generally then that the cost will likely be apportioned on the basis of a tax like our water tax of today. The charge will probably be so much a plug, as we are now charged so much a faucet. Electricity will be so cheap that it will not pay to have meters installed, readings taken and a system of accounts kept.

"Today water is used universally and no one would think of charging a friend or even a stranger for a drink. The same will be true with electricity. When the friend calls with his electric vehicle it will be driven into your cellar and the battery will be recharged while he is making his call. It won't make any difference to your bill, for you are charged for the use of so many plugs or attachment receptacles."

"But what about the factory smoke which will float over our cities?" Dr. Steinmetz was asked. "Will this same day see them entirely electrified?"

"I think so," he said. "High potential lines from the central stations will be able to transmit sufficient power to turn the wheels of industry. Smoke is being eliminated in some instances right now. Coal boilers are still being used, but elec-

tricity is doing away with the smoke and, incidentally, is resulting in the reclamation of thousands of dollars' worth of material that formerly went up and out the chimneys.

Central Stations Play Important Part at Present Time.

"Until that day arrives when everything will be electrified a great deal of the smoke can be eliminated by a central station located on the outskirts which will be automatically coaled. Right now the greater part of our smoke comes when coal is shoveled on in bulk on our fires. If these fires were coaled by automatic stokers there would be very little smoke."

All these changes in our domestic life will tend to revolutionize the appearance of our cities. No dirt, dust or smoke will be permissible, and our cities will be more sanitary. The streets will be beautifully clean. Without fires and with no animals for traction labor there will be no dust or dirt. The atmosphere will be clear, something to be appreciated in those cities today where soft coal is used and the people often find it impossible to see the sky because of the smoke and gases in the air.

With clean pure air we will be able to make our yards more attractive and cities can improve and beautify their parks. Evergreen pine trees can be grown near our homes, adding to the health of the community. These do not grow in the cities today because of the smoke, dust and gases. Trees need fresh air and the needles of the pine trees are their lungs. The evergreen does not shed its needles in the fall as other trees do their leaves, thus replacing their smoke choked breathers with new. It has but one set of needles and in the

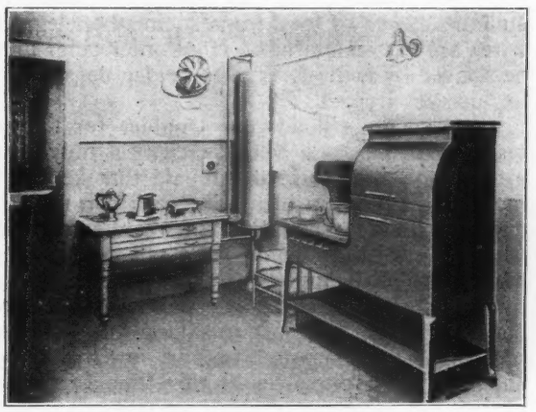
Living Room in "The Home Electrical."

city these become so clogged with dust and smoke that the tree dies from suffocation.

Past Progress Justifies Predictions for the Future.

It is all a pretty picture—this day when everything will be electrical. But for the fact that Dr. Steinmetz foresees such a condition this thought might be dismissed as an over-enthusiastic dream. However, wonderful as have been past achievements, we are safe in believing they will seem insignificant compared with those of future years.

Look back 40 yrs., to 1880, and observe how primitive were many of the conditions of existence as viewed from our present-day standpoint. How did the people of those days manage to get along without the telephone, the typewriter, the cash register, the safety bicycle, the electric street car, the player piano, the skyscraper building with steel skeleton, the wireless, the automobile and a



Electrical Kitchen Shown at Panama-Pacific Exposition.

multitude of minor conveniences now in common use, but unknown then? Look back 100 yrs. and it is like jumping into the dark ages. To suppose we are approaching a limit is absurd. There is no more end to invention than there is to science. Every new scientific discovery gives rise to thousands of inventions. Electrical development is still in its infancy, according to the Schenectady wizard. "Most persons have never stopped to consider just how dependent we are on electricity today," said Dr. Steinmetz. "Living would be almost impossible if electricity should go on strike for a day without notice.

Modern Conveniences Cease With Failure of Electricity.

"Take, for example, a time when you may be attending a dinner on the roof garden of some hotel. Electricity ceases. The place is suddenly thrown into complete darkness. You rush to the telephone to find out what is the matter, but the telephone doesn't work without electricity; you call the waiter and tell him to bring some candles; he hurries to the elevator, for you are on the 20th floor, but the elevator isn't working. He then runs down the long flights to the office, secures candles and returns; the room is poorly lighted but you can see your way out. You face the same long walk down flight after flight of stairs to the main floor. You leave the hotel and plan taking a trolley car home, but the cars are not running. You call for a taxi, but none are able to start; their electric batteries are on strike.

"Being a long way from home, you decide you will remain at the hotel for the night. The best room the clerk has to offer is on the sixth floor, and you have to walk. Struggling your way through dimly lighted halls and stairways you are at last ushered into your room. You feel that you must have a drink before retiring, but when you turn the faucet there is no water for the electric pumps have stopped. You push the button for the bell boy to bring some water, but there is

no response; the bell doesn't ring. So you go to bed and make the best of it until morning.

"Upon arising, you are anxious to see the morning paper to learn what has happened, but there is no paper; the typesetting machines and printing presses can not operate without electricity. So you decide to visit the newspaper office. You are anxious for the news from Washington, from New York, from London and other important places, but the newspapers have no bulletins except of local interest, for the telegraph wires are closed and news from other cities must be relayed by courier, as in the olden days, and it has not yet arrived.

"And so on will be your troubles for the remainder of the day. Yet, electricity is only in its infancy. Benjamin Franklin said that he would like to be sealed up in a wine cask for 100 yrs. and then come out and view the world as it would be at the end of that time. We can imagine how amazed and delighted Franklin would be if permitted to behold the electrical marvels of the present day. Yet, I feel safe in saying this would be but slight as compared to our surprise if we should seclude ourselves at this time for a like period and view the world in 2021."

MOTOR-DRIVEN EQUIPMENT USED IN LOGGING WORK.

High Production Rates Attained With Electric Equipment—Transformers Installed Near Motors to Supply 550-Volt Service.

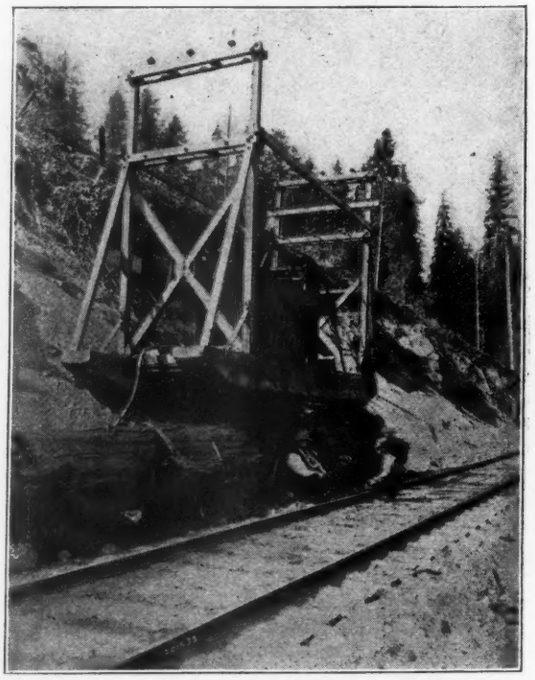
Application of electric apparatus to the various processes in sawmills is widespread, but it remained for the Snoqualmie Falls Lumber Co., Snoqualmie Falls, Wash., to use it on actual logging apparatus in the forest. They have at present for this work in the woods a yarder and

Electric Yarder Installed by Snoqualmie Falls Lumber Co.

loader, both mounted on the same sled. The former is a Williamette Iron Works, Humboldt, three-drum yarder, having for motive power a 200-hp. phase-wound General Electric induction motor used on a three-phase, 60-cycle, 550-volt power circuit. The loader, also built by the Williamette Iron Works, is equipped with two 75-hp., phase-wound induction motors. The two machines each occupy half of a 60-ft. sled which renders them portable.

The power supply for the two machines is stepped up to a pressure of 13,200 volts at the mill power plant by three 250-kv-a. transformers, the transmission line running through the woods. The supply voltage is stepped down by two 250-kv-a., single-phase, 600/13,200-volt transformers at the scene of operations. The transformers are rendered mobile by being mounted on a small sled which is equipped with a disconnecting switch. This sled is set about 500 ft. from the one carrying the yarder and loader, energy being transmitted between them by a flexible armored cable laid on the ground.

Some difficulty was experienced at first in obtaining desired slow speeds on the yarder, but when this was overcome by the insertion of resistance in the rotor winding the operation became satisfactory. In 1918 the machine yarded



Transformer Bank Mounted in Woods to Serve Logging Machinery.

3,144,898 ft. of timber in 44 days, or an average of 71,470 ft. per day. In 1919, due to an increase in the transformer capacity, the average output per day was raised to 77,000 ft. The same efficiency which characterizes the operation of the electric yarder is demonstrated by the loader. In fact, the application of solenoid load brakes to the motor make it possible to compete with a steam-driven outfit. It is also possible by means of this braking system to do one thing which a steam outfit cannot do, namely, to hold a log suspended in midair, or in any position desired. This is made possible by the fact that when power is shut off from the motor the solenoid brake sets automatically so as to prevent any motion.

Results obtained by the electrification of the logging operations are the most convincing argument possible in favor of the electrification of the logging industry generally. Methods that increase production and cut costs are as valuable in lumbering as in any other industry and deserve thorough consideration by those interested.

The road of reckless pleasure has plenty of parlor cars and a smooth roadbed, but most uncomfortable terminal facilities.

The Human Factor in Problems of Power-Plant Efficiency

Training and Co-operation of Workmen Is Vital to Successful Operation of Plant Equipment—Considerable Time Required to Introduce and Establish Improved Practices in Operating Plant

By ROBERT JUNE

In previous articles various power-plant instruments and a number of types of equipment have been discussed, indicating conditions under which these could or could not be used advantageously, and suggesting methods of effecting economies in operation. Since these discussions have followed the lines of accepted good practice the points brought out and methods suggested have the sanction of authority, and constitute a valuable plan of procedure in any program of increasing power-plant efficiency. It is one thing to lay out a program, however, and another to execute it, as anyone who has ever tried to stimulate the morale of an operating force and increase the efficiency of power production knows. The problem of economical boiler and furnace operation contains a large psychological factor which must be taken into account if satisfactory results are to be secured.

Assuming that it is desired to increase the efficiency of a given plant, the first step is the installation of necessary recording apparatus. Only a few instruments are needed for an ordinary plant, but these must be regularly used and the records reviewed and studied. It is a waste of money and effort, and will defeat the ultimate purpose, to go into greater instrumental refinements than the operator can intelligently understand and handle in every particular.

Gauges and Instruments Required in Boiler-Plant Operation.

Every boiler setting should have a draft gauge and draft-gauge system capable of instant and constant indication of the boiler-outlet and furnace draft. Accurate water-measuring and coal-weighing devices are desirable. The chief engineer of a plant of, say, 600-hp. capacity, or larger, should also possess a standard orsat or gas-handling set, and temperature records and observations should be made and preserved. The business of effecting conservation in a steam-generating plant goes far beyond a mere experiment by trial of the sources of preventable loss and the making of suggestions for improvement. If improvements are to be made they must be made under the direction of a competent individual. This may be the chief engineer or boiler-room superintendent, or it may be that an outside engineer should be called in. In any event the individual who is responsible for the improvement has a job on his hands requiring, above everything else, tact and good judgment.

In the case of the outside engineer who is called in to investigate plant conditions, with the object of effecting improvements, his personality is, by all odds, the first and most important consideration. His work will be a bitter disappointment to his client if he does not possess the ability to advance his technical findings in a way that will call into play the loyalty, skill and energy of the men over whom he is to have more or less supervision. It is infinitely preferable to engage a man of mediocre technical likableness than to employ a more learned but tactless scientist, so far as permanent benefits are concerned.

In case outside supervision has been decided upon the engineer assigned to effect the improvements usually visits the plant and goes over its

INSTRUCTIONS TO FIREMEN

General

1. Even load in the neighborhood of 10,000 pounds of steam flow per hour must be maintained on each boiler. Bank one or more boilers if necessary to secure the proper load on each boiler in operation.

2. Maintain even flow of feed water. Permit rise of 8 inches in gauge when load drops rapidl , and fall of 8 inches below normal in gauge in case of sudden demands on boilers.

3. For hand fired boilers. Use the spreading method, firing 8 to 10 shovelfulls at a charge, starting from rear and completely covering fuel bed.

4. For stoker-fired furnaces maintain even fuel bed thickness of 6 inches.

5. Go to instrument board after each firing. If necessary adjust damper draft and ash pit draft in accordance with actual load of steam flow obtaining. (See table in paragraph 6).

6. Regulate conditions as follows;

		Pound Hour.				
WHEN:	Flow per boiler is	8000	9000	10000	11000	12000
THEN	(Ash pit must be	1.2	1.4	1.5	1.6	1.8
	(Damper must be	0.03	0.04	0.06	0.08	0.10
	(Fuel bed must be	4"	4-1/2"	5"	5-1/2"	6"

7. Instrument readings must be recorded every 30 minutes on log charts.

8. Steam pressure must be maintained at 150 pounds per square inch at all times.

Typical Instruction Card Giving General Information for Firemen.

layout; he questions the operating forces, conducts certain preliminary tests, and perhaps places in the boiler room an assistant more or less equipped with knowledge and instruments. The results of this preliminary investigation is usually a report containing statements of fact as to the adaptability of fuel, draft, gas analysis, plant routine and operating methods; it is apt to contain criticisms with respect to all of these, and it may attempt to show the effect of one deficiency upon all the rest. In hardly any instance will the plant be found fully equipped for first grade performance. Therefore suggestions are offered to the management with respect to certain changes or additions to be provided in the equipment, and the reasons are given to support such recommendations. This is all very well. After the

management has gone over the report it will be given the chief engineer to examine, and from him will receive back a guarded criticism of the findings. He praises the report faintly and, because the operating forces have proven themselves loyal and capable in the past, insofar as the management has been able to determine, the effect is to delay constructive action on the program outlined in the report.

The question naturally arises as to why the operating engineer looks upon the efficiency man with suspicion. In the first place, when it comes to intimate knowledge of the details of operation, such as likelihood of sudden extreme demands for steam, or the reverse, the operating man knows from experience the condition in his plant while the outsider cannot possibly get all the facts. The efficiency engineer therefore is at a disadvantage. Probably the operating engineer will in his own mind lay great stress upon some minor matter, while overlooking important phases of operation, and the mere fact that something known to him has not found its way into the report promptly causes him to discount all the rest.

Confidence of Operating Force Required to Accomplish Real Results.

Operating forces are only human, and the spirit of resistance is often set up against any suggestions offered by the outsider. The technique of operation has a more important bearing on the attainments of high efficiency in boiler practice than any other factor; consequently, unless the efficiency engineer can win the confidence and backing of the operating forces his work will be valueless. Modern production practice calls for rapid changes in methods as new and better ways of doing things are discovered. If the boiler room in question supplies a large factory the chances are that the management and all of the factory department heads are thoroughly alive to the frequent necessity of change. They live in an atmosphere of progress and do not hesitate to make radical changes in location of machines and methods of handling operations if these seem desirable. The boiler room is a different proposition. Here the tendency is to refer everything to custom and precedent. The operating men have performed their duties in certain individual ways, and no complaint has heretofore been registered against their methods. Why, then, should a change be proposed?

The first requisite of an improvement is, therefore, ample time in which to effect it. The services of the efficiency engineer are of value to the plant management in increasing proportion to the length of service; that is, the service will be six times as valuable to the management if the time is spread over a period of a year than if it is confined to two months, and three times as valuable as over two months. It takes about so long to work out resistance to change, and the operating forces must be given opportunity to accommodate themselves to the presence of one who stands, for the time being, closer to the management than they do themselves.

Granted tact and technical skill on the part of the efficiency engineer, it would be surprising if the operating forces were not more or less antagonistic to his presence in the plant for a period of two months or more. When the operating men finally realize that the efficiency engineer does not intend to recommend wholesale discharge, and that he is not in the plant for the purpose of showing them up, but rather for the purpose of co-operating with them to the end that they themselves may increase their own efficiency, they will begin to be stimulated by his efforts. If the efficiency engineer has real technical ability as well as tact they will begin to respect him for what he knows and for his character.

Co-operation Ultimately Results in Accomplishment of Improvements.

The process works two ways. The efficiency engineer discovers that his original impressions regarding the plant and the men were incorrect in many details. Real results are finally in a fair way to be attained when the operating men come to look upon the efficiency engineer as a regular employe. It is then much easier to work together and the efficiency engineer can set himself to the real test of his capability. This consists in so managing to suggest his thoughts and methods to the operating men that they will beat him to their expression and execution; in other words, they will adopt the thought or suggestion as their own.

At this point, if the efficiency engineer has managed to get the operating men to advance as their own the ideas he is seeking to inculcate, and he to some extent negatives or depreciates them, the result may be beneficial in that it may cause the operating men to make every effort to prove the correctness of their views. Since the idea is, as they believe, the creature of their own making

INSTRUCTIONS TO FIREMEN

Details

1. On hand fired furnaces. After shaking grates, take scraper and push fires to the rear, leaving bed of hot coals 2" to 3" thick. Throw green coal in front to required thickness, spread lightly in the rear.

2. Maintain level fuel bed at all times.

3. Fires must be cleaned every twelve hours on load less than 2000 KW.

4. Fires must be cleaned every eight hours on loads in excess of 2000 KW.

5. On hand fired furnaces only one fire door may be opened at a time.

6. Weigh and record all coal placed in stoker hoppers.

7. Do not let supply of coal in stoker hoppers fall below level of top of hopper.

8. Keep continuous flow of feed water into boilers.

9. When shifts are changed have feed water at normal level.

10. Blow down boiler every twenty-four hours, starting with boiler #1 at 10 o'clock P. M. Open and close blow-off valve slowly, allowing 2 minutes by watch for complete operation.

11. Operate soot blowers on all boilers three times in twenty-four hours, starting with boiler #1 at - A.M. 5 P.M. and 1 A.M.

12. Blow soot blower units from front to rear of boiler. starting with Unit A in first pass, allow three revolutions of the blower element then shut off steam on this unit and operate unit B in a similar manner, etc.

Typical Instruction Card Giving Detailed Information to Firemen.

unquestioned support will be given to its successful accomplishment. There is no question that the mental attitude of the operating forces has an extremely important bearing upon the successful functioning of the plant equipment. Thus it often happens that in a plant containing one kind of mechanical stoker in successful operation, when a new engineer comes on the job, differences will begin to be apparent in stoker operation which can be attributed more to the prejudice of the engineer than to lack of knowledge or ability on his part to operate the equipment properly. It is therefore of the greatest importance that any man who is set up as an instructor over men who consider themselves already thoroughly trained and competent should possess tact and good judgment. When such a man overcomes the inertia of existing bad habits they will inevitably be replaced by good habits.

The important thing to remember is that it takes time and much patience to accomplish the desired results. Some managers it is true do not have any great confidence in methods such as have been outlined, and, being impatient of results, believe that the quick and sure way to accomplish reform is to perform at once a surgical operation by discharging the old crews or at least their chiefs.

Best Results Attained by Retaining Existing Organization Where Possible.

It is the writer's opinion, however, backed up by the experience of men who have tried both methods, that the best results are not secured by wholesale firing. A new chief and new assistants are at a loss when it comes to detailed knowledge of plant conditions, and the time which it takes to familiarize themselves with these details is largely lost. True, they are less inclined to criticize and withhold co-operation, but they are less capable of making helpful suggestions and of adapting the ideas put forth to the actual plant conditions. Unless there is actual insubordination and continuous attempts to hamper the work of the efficiency engineer, it is far better to retain the old men who will have at the start of their education a close knowledge of the systems, materials and equipment with which they have to work.

All that has been said regarding the necessity for tact, good judgment and the use of a little practical psychology on the part of the efficiency engineer applies equally well if there is to be a permanent instructor inside the plant. That there is ample need for constant training and instruction of power-plant employes is a fact generally recognized by experienced engineers. It is clearly the duty of the management to provide proper training for its employes, and any management which fails to do this is negligent of its duties and opportunities. Necessarily, the means provided will depend entirely upon the size of the plant and the operating conditions. Thus, in a large central station there may be permanent instructors with each shift in the boiler, pump, turbine and high-tension rooms, on the switchboard and with the repair gang, whereas in the smaller plant a single individual may act both as instructor and supervisor. Between these two extremes a number of variations are possible. The point should be clearly borne in mind that the expense of such training is small in comparison with the savings which can be effected through the work of well-trained crews.

Training Requires Long and Constant Effort.

The truth must be realized that only by prolonged training can an adult who has been given his own way for many years be brought to form new habits. He may recognize the value and importance of doing things by newer methods, yet, if all his life he has been accustomed to doing them in a certain way, it will take time, effort and patience for him to change. But because this change is absolutely essential it should be conscientiously and patiently striven for by both the instructor and operator.

The value of correct methods is apparent. Thus, boilers during periods when tests are conducted by experts give efficiency results which are almost never attained in average daily practice. Granted that the conditions of load and service during tests conformed to normal requirements, the only explanation of the failure on the part of the operating crews to maintain equally good efficiencies is that they do not carry on the work in the same way the experimenters did. Lack of knowledge and, perhaps, lack of incentive are the real reasons for this failure. In very few plants do the fireman receive any training other than a few words of instruction after which they are left to shift for themselves. As for helpers and coal passers, they are expected to learn by personal observation of the routine work done by others. Such a process of education, if such it may be called, is of too long a duration at its best, and it is extremely wasteful in both fuel and labor.

After training and instruction have been given verbally and by example until the men have reached a certain degree of proficiency, the time is at hand to standardize operations and to put them in writing. Typewritten cards should be placed in the boiler room. These cards should detail all operations, and the men should be checked up on their knowledge and compliance with the typewritten instructions. Typical cards are shown in the accompanying illustrations. These cards can be worked out for each individual plant, and they are certainly desirable tools for effecting efficient operation.

HOME-BUILDING PLAN LAUNCHED BY WESTERN ELECTRIC CO.

Employes Backed by Corporation, Fight Cost of Living Through Organization Known as Hawthorne Club Savings Association.

Employes of the Western Electric Co. at its big plant near Chicago have evolved their own scheme of solving the rent question. The Hawthorne Club, the plant employes' organization, which has over 25,000 of the factory personnel on its membership lists, has developed two plans. One offers a means of lowering the costs per person desiring to build; the other is a financing system on the building and loan idea. The state of Illinois has just granted a charter to the Haw-

thorne Club Savings, Building and Loan Association for a period of 99 years.

The new association is issuing three classes of stock to its members. Its class "A" stock, which has a maturity value of $100 per share, is paid for at the rate of $0.25 a week per share. At the average profit of a building loan organization, the "A" securities will be paid for in 328 weeks, or a little more than 6 yrs. The subscribers who are anxious to build can obtain a loan representing the entire maturity value of the stock to which they have subscribed, immediately after their application for the stock is accepted. It has been figured that they will pay only a trifle over 3% a year on their debt instead of the legal 6%. They will save all the mortgage renewal fees, and many of the legal fees that weigh down the average homebuilder. The class "B" stock is similar to class "A," except that it is paid at the rate of $0.125 a week. It matures in about 11.5 yrs. The class "C" stock is issued on payment of $75 per share. It participates in the association's profits. As soon as the profits reach $25 a share the stock can be cashed at its maturity value of $100.

The Hawthorne Association operates under a serial plan. Members are admitted only on the first Thursday in March, June, September or December. A board of employe directors passes on all loans before they are granted. There are nine members. The average term of service with the Western Electric Co. of the men on this board exceeds 18.5 yrs. Some of them are experts in appraising Chicago property. Although just getting under way the Hawthorne Association has about all the business it can handle comfortably, 534 subscribers having taken a total of 6812 shares in the two series which have been issued. The board of directors is now acting upon applications for loans totaling approximately $50,000.

SPIRIT OF CLOSER CO-OPERATION ADVOCATED.

Oklahoma Utilities Association Discusses Public Utility Regulation and Closer Relationship Between People and Utility Companies.

Public utility regulation should be "intelligent, prompt and fearless," declared Campbell Russell, chairman of the Oklahoma Corporation Commission, at the third annual convention of the Oklahoma Utilities Association. He also stated that regulation should be in the hands of a body that would accomplish these three things.

John W. Shartel, Oklahoma City, vice-president and general manager of the Oklahoma Railway Co., asserted that a narrow and restricted policy in Oklahoma toward public utilities was preventing the building of 2500 mi. of electric interurban railway that could be profitably operated if investors were not haunted by the fear that they would lose their money through restrictive legislation.

Paul P. Haynes, Indianapolis, member of the Indiana Public Service Commission, advised a closer spirit of friendliness and co-operation between the people and the utility companies. The convention was in session 3 days and 300 delegates were in attendance.

The election of officers resulted as follows: President, John W. Shartel; first vice-president, C. E. Devin; second vice-president, F. A. Willard, and manager, H. A. Lane, 1107 First National Bank building, Oklahoma City, Okla.

DESCENDANT OF BENJAMIN FRANKLIN SEES ELECTRICAL WONDERS.

Nothing could more strikingly show the amazing progress made in the application of electricity than the accompanying illustration of the great-great-great grandson of Benjamin Franklin, dressed in the garb of his illustrious relative, examining one of the gigantic Westinghouse rotary converters that furnish power for the Pennsylvania railroad station in New York City.

It is barely 150 years since "Poor Richard," as Franklin often is termed, touched his knuckle to a key attached to the silken cord of a flying

Descendant of Franklin, Dressed as Franklin, Viewing Modern Electrical Equipment.

kite and drew a spark from the skies. That spark sent him on an electrical research which he followed until his death in 1790. Could he have returned during the celebration of "Thrift Week" to go about with his direct descendant, Franklin Bache Huntington, it is very probable that the man whom "kings and paupers honored" would have derived the greatest satisfaction from seeing the modern application of his spark from the skies.

Standardization is now being applied to human energy in the electrical industry.

Laboratory Service for a Modern Public Utility

Bureau for Extension of Research, Conducting of Mechanical and Electrical Tests and Development of New Devices, Proves Economically Valuable in Operation of Central-Station System

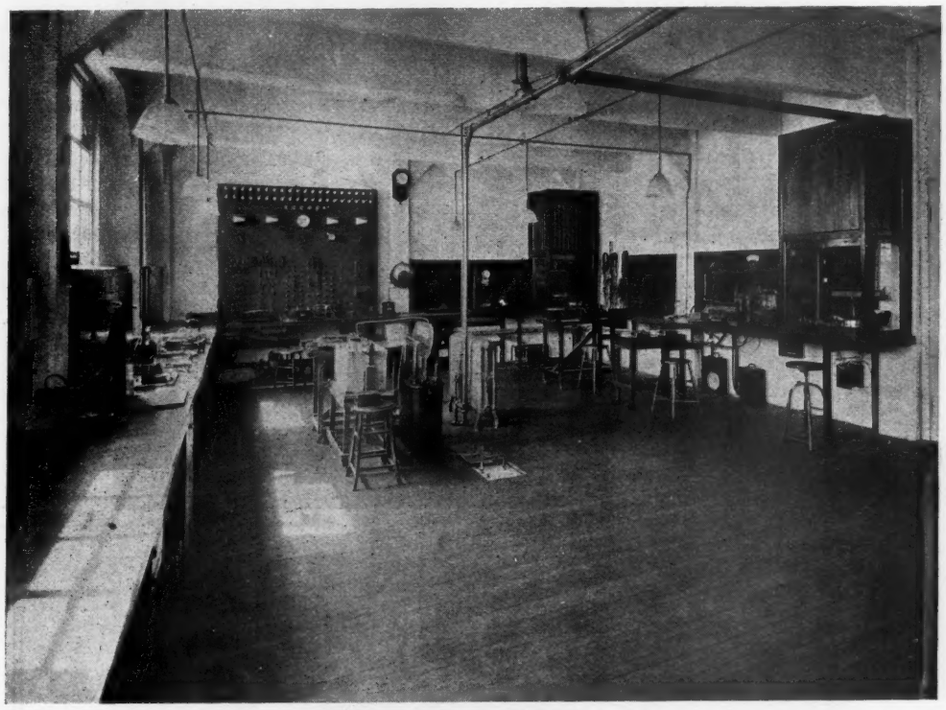
By O. A. KNOPP

Superintendent, Bureau of Tests, Pacific Gas & Electric Co., San Francisco.

In the past few years the research and testing laboratory has become a more and more appreciated and valuable establishment in the industrial life of the nation, according to *Pacific Service Magazine*. The war has taught us that no great industrial undertaking can progress speedily and economically unless it avails itself of the service of a well equipped and scientifically conducted laboratory.

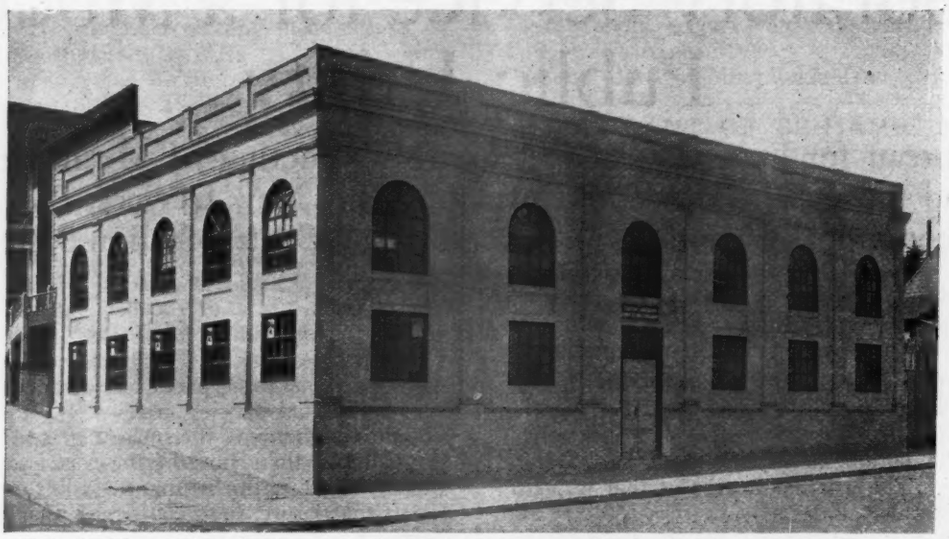
This trend of thought probably had great weight with the management of the Pacific Gas & Electric Co. when, in the fall of 1919, new and suitable working quarters were chosen for the electric laboratory formerly located at 25 Hyde street, San Francisco, and led finally to the creation of the "Bureau of Tests" as a branch of the new department of engineering. The new quarters are in the building of the old station "E," situated at the southwest corner of Mariposa and Vermont streets, with entrance at 2101 Mariposa street. The space in this building is approximately 4400 sq. ft., compared with about 1800 sq. ft. occupied by the former laboratory. The building is constructed of reinforced concrete and erected on solid rock, making it particularly suited for laboratory work.

The functions of the bureau of tests are of a wider scope than those of the former laboratory, since, in addition to former activities of a strictly electrical nature, new work of inspection and tests of a mechanical nature has been added to take care of the requirements of the civil engineers, steam engineers, etc. But the basic functions are the same—to standardize and keep in calibration the numerous portable instruments employed in testing over 200,000 meters used in measuring the power from and to stations, or to consumers; to keep in working order the multitude of delicate instruments and apparatus used in conjunction therewith, and to develop special testing instruments, relays and devices to suit the requirements arising constantly in a large and progressive central-station system.

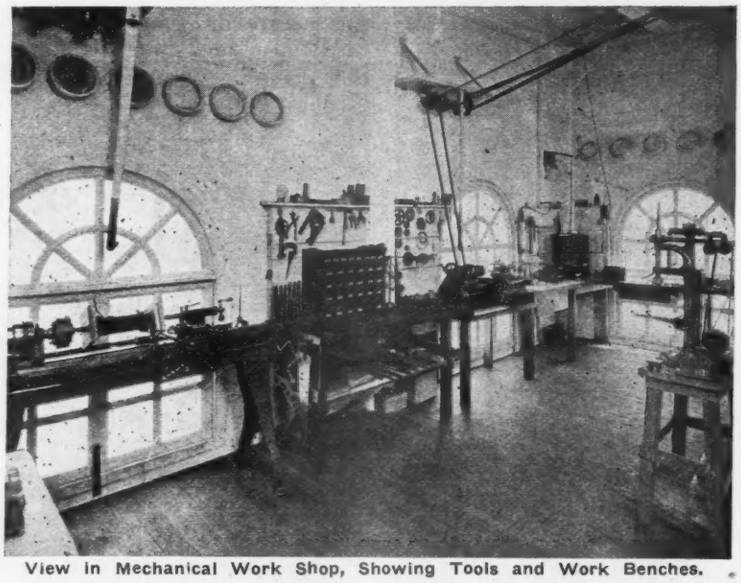


Main Test Floor and Standardization Room, Showing Potentiometer, D-C. Test Bench, Glove-Testing Outfit, Etc.

The equipment of the laboratory consists of primary electric standards, including a potentiometer and galvanometer, standard cells, standard voltmeters, milli-voltmeters, wattmeters and numerous special types of fine measuring instru-



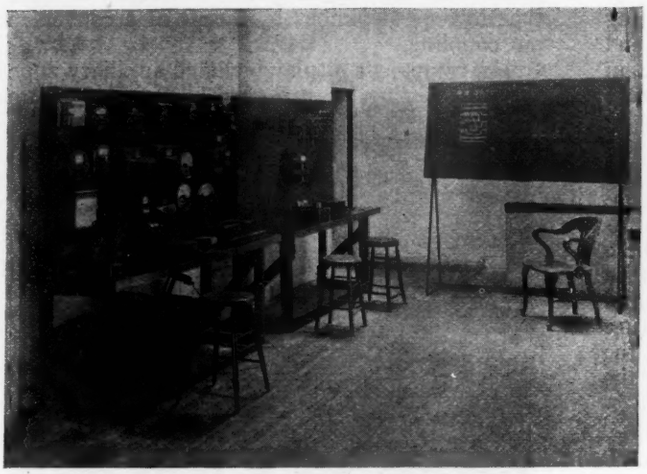
Exterior View of "Pacific Service" Electric Laboratory Building, Situated at Mariposa and Vermont Streets, San Francisco.



View in Mechanical Work Shop, Showing Tools and Work Benches.

Instrument Cabinet in Standardization Room.

ments; several motor generators, batteries capable of delivering 4000 amperes, batteries for operating motor generators to deliver steady alternating current, others to generate steady high-potential direct current, special transformers for heavy-current work and for high potential in testing insulating material and linemen's rubber gloves, phase shifters and numerous other pieces of apparatus for translation and precise regulation.



View in Museum and Meter Tester's Instruction Room.

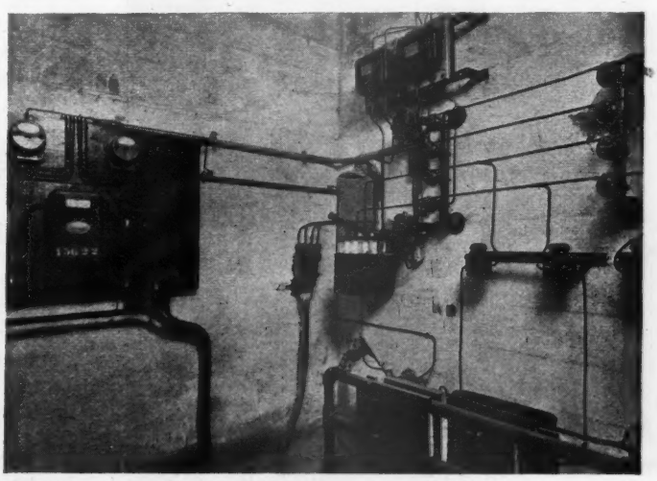
Several new test benches, controlling devices and switching facilities have been added to the old equipment to economize on labor and to improve the accuracy of the test results. A photometer has also been installed. This photometer was formerly located at Fifth and Tehama streets, where it could not be used to advantage.

It is the intention, as ample space is now provided in the laboratory, to centralize all apparatus of a laboratory nature and thus secure the full advantage of all equipment of this nature available, since in all classes of testing work there are fundamental requirements for the measurement of electrical, magnetic, mechanical and thermal quantities. That such is the case was demonstrated recently when scientific tests were conducted on material of nonelectrical nature. The object was to determine the relative efficiency of different makes of steam-pipe coverings; that is, to decide which would save the greatest amount of fuel if used in a steam plant.

In order to reduce the cost of operation and maintenance of the system to a minimum, equipment has to be kept up to date by the introduction of many new equipments and devices constantly appearing on the market. To select the apparatus most suitable for existing operating conditions, such as relays, time switches and other auxiliary apparatus, is the most important work the laboratory is called upon to do outside of the repair, calibrating and standardization of instruments.

A number of interetsing developments have been made in the laboratory during its existence. Several made within the last five years might be worth mentioning, as they have been giving valuable service for some time. One of these developments is an auxiliary apparatus used in connection with maximum-demand measurements—a so-called "Duplex Device"—an inexpensive and reliable contrivance without moving parts. This device has made it possible to record on one demand meter the maximum demand of the combined service given a customer over two different circuits, as is the case in San Francisco where a great many customers have both a-c. and d-c. service. In other cases, where two a-c. services are given of different voltages, it saves the expense of additional transformers and lines, or an additional high-voltage meter installation. Another improvement is the development of a so-called calibrating transformer or magnetic current balance for the calibration of ammeters, wattmeters, watt-hour meters and current transformers. By

Corner of Transformer Vault, Showing Meters and Wiring.



means of this device a great saving in time has been made in the routine work of the laboratory.

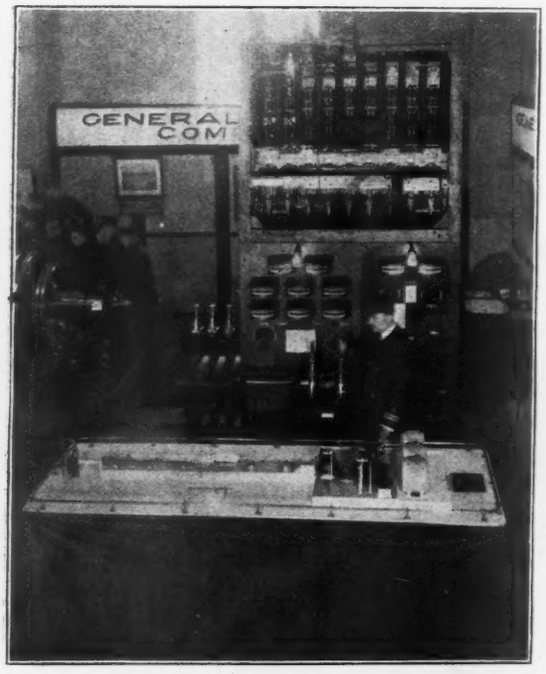
In order to facilitate the measurement of current over a wide range by troublemen and engineers, several multiple-range ammeters were developed and built so that one single lightweight instrument will do the work of seven, cutting down the calibrating and maintenance cost and also the transportation charges and the time in testing. These instruments have become very popular with the few who know that such an instrument is available.

The cost of developing devices of this nature has been negligible. Many new ideas and problems have constantly been brought to the laboratory, and there are given careful study. These studies, experiments and developments have been helpful to many departments, and more good and more valuable work will emanate in the future from the Bureau of Tests in proportion to the recognition and encouragement given it by the men on the system.

SHIP-PROPULSION EQUIPMENT AT MARINE EXHIBITION

Model of Electric Driving Machinery Shown in Operation—Moving Pictures Used to Demonstrate Progress.

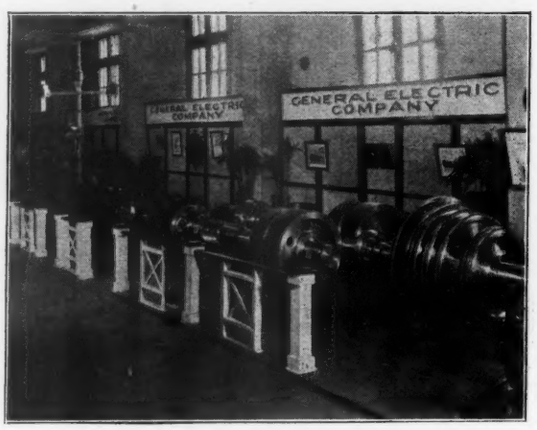
Unusual interest was displayed in the General Electric Co.'s exhibit at the third National Marine League Exposition at the Grand Central Palace, New York City. Appealing to the popular mind as well as the marine engineer and shipbuilder, perhaps the feature of the company's show lay in a miniature model of the electric pro-



Model of Electric Ship-Propulsion Equipment—Ship Control Panel.

pulsion apparatus of the *S. S. Eclipse* displayed in actual operation and controlled through a switchboard similar to that on the original vessel. This model, built by the Vulcan Iron Works, was the center of an admiring crowd throughout the whole of the exposition. Vieing in interest with the electric model were the rotary parts of a 2500-hp. marine-geared turbine, including thrust bearing and emergency governor with high-speed pinion and high-speed gears, connected to quill-type low-speed pinions by means of a convenient pin coupling.

The company's display included auxiliary apparatus consisting of a forced-lubrication, steam-



Turbine Runner and Reduction Gear for Ship Propulsion.

engine-driven generating set with control panel, a 10-hp. and a 50-hp., 230-volt d-c. motor for engine-room use, and a 230-volt d-c. motor of 25-hp. capacity, equipped with disk-type magnetic brake, for unloading cargo. There was also a W. D. 9 arc-welding set and control board, and three searchlights, all of which were in operation. There was also a thrust bearing in operation.

The searchlights were grouped below a mast on which were a set of mast lights, running lights and blinker, the latter operated by a key and all controlled through a tell-tale board.

Photographs of well-known vessels, steam-turbine diagrams and a sketch of an electric-propulsion outfit were also included, as well as numerous bulletins and literature. During the progress of the show two feature films, "The Queen of the Waves," tracing the evolution of transportation methods, and "Revolution," depicting the manufacture of X-ray apparatus, were shown.

THE PLACE OF THE SMALL MOTOR IN MANUFACTURING.

Although it is generally conceded that it is best to drive large tools by individual motors, it requires considerable argument frequently to get the manufacturer to see the advantage of using individual drive for smaller machines. There are many cases where group driving of small machines (used the greater part of the time together) is satisfactory and possibly cheaper, but the flexibility, ease and accuracy of control and independence of operation are just as marked with small machines individually driven as with larger ones. The effect of power losses in shaft bearings, pulleys and belts is well known. Where a-c. motors are to be applied, the power-factor must be taken into consideration and is an important item in determining the kind of drive.

EDITORIAL COMMENT

Next Winter's Load

With the passing of each winter season, and the consequent falling off of load, many plant engineers feel the relief from a strain just as heavy as that carried by their plant. Most engineers determine during the winter, when every unit of equipment is working to the limit, to see that another winter will not find them and their plants unprepared. But with the slackening of load there is a tendency to "let things ride" for a few days or weeks until conditions are still further relieved.

Fortunate, indeed, is the man who can let things ride when springtime comes, but more fortunate still is the man who takes up his overhauling and re-equipment problems promptly and actively. In all probability the plant that came easily through the winter season had been well gone over during the previous spring and had faced the winter peak loads with all new equipment well tried and ready for its best service. The engineer in such a plant has little to fear.

Right now is the time to get ready for the coming winter. Old stokers should be overhauled and have new parts installed wherever needed. A thorough job of repair undertaken at the present time will put the entire equipment in the best of condition when the heavy load comes on again. It may be that old and inefficient equipment should be replaced with new and improved designs. Many plants are allowed to continue to operate in the old way established years ago, when a little investigation might show that vastly better and more economical practices could be adopted. Stokers, coal scales, water meters, ash conveyors, draft gages, CO_2 recorders, soot blowers, feed-water regulators, thermometers, tight baffles, tight walls, tight breechings, good dampers, tight inspection and cleaning doors, and many other features about the boilers themselves all pay good dividends on their cost and maintenance.

Leak and radiation losses in pipe lines are not the least of the factors to be considered. Loss of heat by radiation is likely to assume greater proportions than the operators of most power plants realize. It exists just as long as there is heat to be radiated, and the fact that this loss goes on silently and invisibly makes it none the less real. That the loss of heat by radiation is sufficient justification for giving the matter of prevention serious consideration may be emphasized by mentioning the fact that every 1000 sq. ft. of exposed surface, at 100-lb. steam pressure, results in a coal consumption of more than 300 tons annually.

The reduction of radiation losses is for the most part a simple matter, and the extent to which it is carried is a question of determining to what extent it is financially worth while to save heat lost by radiation. It is a matter of balancing the cost of heat lost against the cost of insulating the exposed surfaces against that loss. The problem involves the cost of heat, the length of time the loss exists, and the cost of reducing the loss. It is not, therefore, a matter of *eliminating* radiation losses, which is scientifically as well as financially impracticable, but of reducing them in the proportion that pays. It does not pay to reduce radiation heat losses to such an extent that the cost of doing so exceeds the cost of allowing that heat to be lost unless there are other factors involved.

Because radiation losses are so easily reduced they are classed as preventable. And no preventable loss should remain unprevented. Of the preventable losses, that by radiation is the one most easily overcome, and no other single loss remains overcome so permanently or so cheaply. In other words, money spent in the reduction of radiation losses is money well spent, and when once spent begins to save money without necessitating further expenditures to keep the investment sound.

Now is the time to start the season's repair program. All repairable or renewable equipment should be put in shape while new equipment is being obtained from the manufacturer. Then, when the new devices arrive, the way is clear for their installation. With all new and repaired equipment and connections in place, pipe lines, boiler shells, feed-water heaters and other devices can be covered with heat-insulating materials, and the engineer can face the coming winter with the assurance that he can supply the winter's demands with certainty and economy.

Electrical Welding in Ship Construction

Some interesting details have recently been made public concerning a vessel constructed in England which was built without a single rivet in her. This ship, the *Fullagar,* is a coasting steamer 150 ft. long by 23-ft., 9-in. beam, with a cargo capacity of 25,000 cu. ft. and a speed of 10 knots. Electric welding by the quasi-arc process has been used throughout and the results are entirely satisfactory. A butt weld with a strap behind has been used mainly where plates are joined end-on; the strap being attached to one of the plates by a light fillet which can be easily

put on while the plate is still in the yard. The main weld is then carried out by working downward, overhead welding being avoided as far as possible. In the case of lap welds between plates, a continuous weld is put on both sides. A great deal of careful study is necessary to determine the best methods of carrying out the various details of so large and important a piece of electrically welded work, but from information in hand at present, it seems to have been a decided success.

Adjustment of Power Complaints

No phase of central-station work is more important than the adjustment of complaints from consumers bearing upon the quality and cost of service. The holding of business, and to no small degree, the securing of new revenue, are directly concerned with this problem. There is a tendency for complaints in the lighting field to overshadow those related to motor service, probably because of the personal element and because of the close regulation demanded in high-class illumination. Power complaints should receive the most detailed study, and if necessary a test should be made on the consumer's premises in his presence, or with his representative at hand, to determine the real cause of trouble. The cost of such work may properly be borne by the central station, unless elaborate and expensive instruments and an unusual testing organization are required, when it may in some cases be feasible to divide the extra burdens involved. As a rule, there is less danger of captious criticism from the power user as compared with the lighting customer.

In a typical instance, a customer was using a 15-hp., single-phase motor in the operation of a woodworking factory. A complaint of high bills was received, with criticism of the voltage regulation. The central station made a somewhat delayed investigation and found that the low voltage was due to the fact that the transformer supplying current to the motor was over a half block distant. The high bill was found to be due to the poor load-factor of the motor, which ran for 75% of the time with a load of 5 hp. or less, and to the friction loss in the shafting. It was found that the complaint had been made some time before it received attention, and that as a result the plant owner had ordered an engine and boiler to take the place of the motor. After the cause of the complaint was remedied, the order for steam equipment was countermanded. As in many cases where motors are poorly fitted to their initial work, or where changes in the connected load alter the conditions without the knowledge of the central station, the situation was cleared of trouble with little difficulty. The transformer was located near the motor, the line shafting divided and the machines regrouped, so that the lighter apparatus was driven by a 5-hp. motor and the heavier equipment by a 10-hp. unit. The results were so satisfactory from the standpoint of bills and quality of service that when the plant was enlarged 45 hp. more in electric motors was installed.

The case illustrates how attention to a complaint with a comparatively simple remedy saved the original business from being taken away and ultimately led to an increased patronage of 300%. The moral is obvious, and is well worth the consideration of central-station managers.

Hydroelectric Prospects in India

A considerable amount of study has been given during the last two years to the possibilities of further hydroelectric developments in India. An interesting abstract of the work recently done by the government of India appears in the London *Electrician* of current issue. It would seem from the report prepared by F. E. Bull, chief engineer of the Hydroelectric Survey, and J. W. Meares, electrical engineer of the government of India, that many sites offer good prospects of economical development. Nearly all these sites involve problems of adequate storage, and accurate data will have to be accumulated before sufficient information regarding rainfall and discharge from the catchment areas will be available as a basis for correct estimates of operating possibilities. Although the survey is not yet completed, it is estimated that from 22,000 to 38,000 kw. could be generated on the Subarnarika river, and 7500 kw. on the Dumragarhi.

In the Bombay Presidency the prospects are exceptionally good, although in many areas irrigation has a prior claim. About 40 possible sites are referred to in the report, representing a total development of about 220,000 kw., including an item of 67,000 kw. on the Kalinadi and Pandri rivers.

Burma offers more possibilities than any other province. Sites have been located with power ranging from 10,000 to 30,000 kw., together with sites for smaller developments up to 7500 kw.

In the Central Provinces some sites with possibilities of about 60,000 kw. are referred to, while in Madras the individual stations would be of smaller size with a maximum of about 13,000 kw.

In some of the other provinces the prospects are fairly good, although the distance from the center of power utilization is a factor of importance in many cases. It is probable that the next few years will see considerable increases in the number of hydroelectric power stations in operation throughout India.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

N. E. L. A. EXECUTIVE COMMITTEE MEETING.

Progress of Work Reviewed by Section Chairmen and Good-Will Program Discussed—Convention Committees Appointed.

The National Executive Committee of the National Electric Light Association held a meeting in room 1741, Edison building, Chicago, March 15. There were 17 members present, making it the largest Executive Committee meeting held this year. Reports were presented by all four section chairmen regarding the progress of the work during the year and the nature and character of the reports to be made at the convention to be held at the Drake Hotel, Chicago, May 31-June 3.

Some details of the convention program were worked out, which will be announced later. E. W. Lloyd, of the Commonwealth Edison Co., who is a member of the Executive Committee and a past-president of the N. E. L. A., was appointed chairman of the Convention Committee and will have charge of all the arrangements for the convention. He has appointed E. A. Edkins as chairman of the Hotel Committee and Mr. Atkins, Chicago representative of the Electric Storage Battery Co., as chairman of the Transportation Committee.

The matter of the good-will program was taken up and discussed at length and the Executive Committee unanimously voted to carry on the campaign and authorized the preparation and publication of a second series of the "Kilo Watt" pamphlets. The question of preparing a motion picture as the first of a series of good-will motion pictures was taken up and referred to the Executive Committee and the Public Relations Section for definite action, which means that the association will go ahead with it in connection with its good-will campaign.

"SEEK PUBLIC CONFIDENCE," SAYS MARTIN J. INSULL.

Joint Meeting of Illinois Public Utilities Develops Greater Strength of Purpose and Results in More Active Co-operation.

"Millions of homes are yet to be made electrical, hundreds of thousands of farms and industries are awaiting electrification, and many new technical and commercial questions are arising that must be solved in the near future," said Martin J. Insull, of Chicago, president of the National Electric Light Association, speaking before the joint convention of the Illinois State Electric, Illinois Gas, and Illinois Electric Railways Associations, at the Hotel Sherman, Chicago, March 15-16. He declared that the speed with which this will be accomplished depends almost wholly upon enlightened public opinion and public co-operation. Mr. Insull said in part:

"There has been so much talk of the 'little lacks' rather than the 'big facts' concerning this marvelous industry that the public mind has become somewhat confused. It is a civic duty, not only of the men responsible for continuance and development of the electric, gas, telephone and transportation services, but of every business man and citizen interested in the welfare of his community and in the bringing about of general prosperity, to see that everyone is possessed of the truth.

"The tremendous necessary electrical development can only be brought about for the people through an enlightened public opinion and understanding of the problems of the utilities. Vast steam plants, greater hydroelectric development and many physical connections and extensions of service are necessitated for the public good, but unless this demand can come from an educated populace who will appreciate the value of the service and be willing to pay what it is worth, progress will be slow. Great as are the achievements of the utilities in the last 25 yrs., still they are not entirely miracle workers for they cannot obtain men and money and materials at less cost than any other industry. The development work must be paid for and the vast additional money for investment must come from those who are thrifty and save, and who have confidence in the prosperity of the industry.

"Good-will is a corollary of confidence, and confidence can be obtained by going straight to the public with a full and frank explanation of difficulties as they arise. The utilities, up until the end of the war, had grown used to keeping their troubles to themselves. They felt no one, other than their security holders, were interested in information relative to their investment, the small margin on which earnings were computed and the necessities for constant expansion of plant and distribution systems. But the war changed that situation. They have learned that the public has an honest interest in the preservation and development of service and that problems arising out of public regulation, advanced costs of operation, unexpected and excessive demands for service and the stringent money market are acknowledged by the public at large to be of great importance. There has been a new and pleasant relationship built up between utility and customer that will mean much in future progress in the industry.

"The entire question of good-will, of finances, of development and of service in reality forms a circle. That community which does not come to a realization of the fact and which continually harasses its utilities soon comes to a stern appreciation of the fact. Unless investors can be prevailed upon to believe that a community is progressive, that it is a safe place for investment and that it regards capital invested in it for the public good as a friend rather than an enemy, they will take their savings to some more enlightened and

friendly community. And as every community is best known to strangers or even to its own people by the extent of its electric, gas, transportation and telephone development, the prosperity and ability of the city or town to grow hinges to a great extent upon the utility investment made in it.

"Billions of dollars will be required to finance the development of the electrical facilities of the country. This money must come down from the investing public. We must be able to show a satisfactory return upon capital already invested and evidence of the ability to maintain a reasonable return on the additional capital that will build the plants the nation needs. There is a self-interest on the part of every citizen, rich or poor, that appeals in this great effort which means greater convenience and comfort to all of the people, the lightening of labor's load, more pleasant and healthful homes and factories, and conservation, at the same time, of the dwindling fuel resources of the nation."

Large Construction Program Planned by State Utilities.

The joint convention resulted in the discussion and outlining of a tentative construction program throughout Illinois in which the utilities plan to expend at least $300,000,000 during the next 3 yrs. R. V. Prather, secretary of the Illinois State Electric Association says that this construction program is contingent upon the co-operation of the investors of the state, who will also be largely benefited with the general public as the result of the expansion of the utilities.

Frank J. Baker, vice-president of the Public Service Co. of Northern Illinois, disclosed that 1,400,000 citizens of the nation own stock in the central-station industry. That 10,000 farms in Illinois are equipped with electric light and power was announced by Marshall E. Sampsell, of the Central Illinois Public Service Co. All speakers dwelt upon the need of re-establishing public confidence in utility securities as an investment so the $300,000,000 construction program may be carried out within the next 3 yrs.

Illinois ranks first per inhabitant in the amount of money and development of its electric utilities, second in wealth and railway mileage, second in electric railway trackage and investment, second in telephone investment and development, and third in manufactures of the 48 states of the Union, according to the annual joint statement of the Illinois State Electric Association, Illinois Gas Association and Illinois Electric Railway Association just made public.

In 1905 the investment in electric, gas, electric railways and telephones in Illinois was but $375,000,000 or about $75 per inhabitant, this being sufficient to meet the public demand for service. On Dec. 31, 1920, the investment was more than $1,300,000,000, or $192.20 per man, woman and child in the state. The demand for service has increased at such rapid rate that $125,000,000 a year is now needed from investors for additional plants and equipment and the number of employes is in excess of 180,000, while owners of securities of the utilities number close to 450,000. These securities are owned by more individuals than any other group of investors, save those who purchased Liberty Bonds during the war period, and many insurance companies, banks, lodges and trust funds are also owners, giving indirect ownership to nine out of ten people. Statistics show that women hold one-third of the outstanding securities.

The estimated investment in public utilities in the state is given as follows: Electric railways (city and interurban lines) $456,000,000; electric plants and equipment, $362,000,000; gas plants, $181,000,000, and telephone plants, $261,000,000. These estimates are based upon a known appraised value of $1,252,000,000 as of June 1, 1920. Electric railways showed the least development in the last year, owing to high operating costs and controversies over fares which resulted in investors becoming unfriendly towards that branch of the industry and cautious about furnishing new money for further development. The greatest gains were shown in the electric and telephone industries.

John F. Gilchrist, vice-president of the Commonwealth Edison Co., Chicago, explained that the utility companies, unlike industrial corporations, did not have the money to indulge in high inventories at the close of the war and are therefore in a better position now to invite public confidence. There were six papers presented in the Electrical Section during the 2-day session, each of which was ably discussed by practical and experienced members of the industry.

DIRECTORS' NOMINEES FOR A. I. E. E. OFFICES.

At the meeting of the board of directors of the American Institute of Electrical Engineers held in New York City March 11, the report of the Committee of Tellers and its canvass of the nomination ballots cast for candidates for the Institute offices falling vacant July 31, 1921, was presented. As required by the constitution of the Institute, the board then selected by ballot its list of "directors' nominees," with the following result:

For president, William McClellan, Philadelphia. For vice-presidents, W. A. Hall, Boston; N. W. Storer, Pittsburgh; W. A. Del Mar, Yonkers, N. Y.; C. G. Adsit, Atlanta, Ga.; J. C. Parker, Ann Arbor, Mich.; F. W. Springer, Minneapolis, Minn.; H. W. Eales, St. Louis; Robert Sibley, San Francisco; O. B. Coldwell, Portland, Ore., and F. R. Ewart, Toronto, Ont. For managers, A. G. Pierce, Pittsburgh; R. B. Williamson, Milwaukee, and Harlan A. Pratt, New York City. For treasurer, George A. Hamilton, Elizabeth, N. J.

I. E. L. A. DISCUSSES ILLUMINATION AND HEATING SERVICE.

Among the features of the Commercial Section meeting of the Indiana Electric Light Association held recently in Muncie, Ind., were papers presented on "Customer Ownership of Public Utilities," by R. H. Moran, manager of the stock and bond department, Interstate Public Service Co., and "Central-Station Steam and Hot Water Heating," by H. C. Kimbrough, secretary of the American District Steam Co., North Tonawanda, N. Y. Mr. Kimbrough stated that electric energy and heating service should be a combined study. Heating service can be furnished as live steam or

as exhaust steam and as hot water after circulating in the condenser. By means of the compound turbine now available, and by bleeding steam between the high and low pressure elements, or taking it from the exhaust, considerable flexibility exists for operating with economy, according to season.

W. D. Campbell, manager of the Indianapolis office of the Sprague Electric Works of General Electric Co., spoke on "Electric Industrial Hoists," while the subject of "High Intensity Illumination" was covered by O. F. Haas, illuminating engineer, Nela Park, Cleveland.

TO DISCUSS STREET LIGHTING AND RATE MAKING.

Ohio Electric Light Association to Hold Annual Convention at Cedar Point in July—Tentative Program Announced.

The 27th annual convention of the Ohio Electric Light Association will be held at the Breaker's Hotel, Cedar Point, O., July 12-15. The sessions and exhibits will be held in the large convention hall, and the same general plan will be followed as last year by having the exhibits on each side of the hall and the meetings held in the center of the room. The following is the tentative program as planned by the Executive Committee of the Association:

July 12, 2:30 p. m.—President's address; secretary-treasurer's report; appointment of Nominating Committee; report of Illumination Committee by W. S. Merrill, Nela Park, Cleveland, and symposium on street lighting.

July 13, 9 a. m.—Report of Meter Committee by S. C. Henton, Akron, and an address on "Rate Making."

July 13, 2:30 p. m.—Report of Transmission and Distribution Committee by Prof. A. M. Wilson, University of Cincinnati, and report of Farm Service Committee by J. C. Matthieu, Dayton (O.) Power & Light Co.

July 14, 10 a. m.—Report of New-Business Co-operations Committee (industrial power and heating section), by M. W. Arthur, Akron, and report of the lighting and merchandising section by J. L. Gaston, Union Light, Heat & Power Co., Covington, Ky.

July 14, 2:30 p. m.—Addresses by G. C. Maxwell, secretary of the Public Utilities Commission of Ohio, and a banker whose name will be announced later.

July 15, 10 a. m.—Report of Station Operation Committee by Prof. Henry B. Dates, Case School of Applied Science, Cleveland, and election of officers.

SHOWROOM EXHIBITS PLANNED BY NEW YORK EDISON CO.

The recent electric vehicle exhibition held at the showrooms of the New York Edison Co., Irving place and 15th street, New York City, proved so successful from every standpoint that the company is planning to periodically make use of its showrooms for the display of other electrical conveniences. Accordingly an exhibition of electrical refrigerating equipment, including various types of machines for apartments and dwellings and the larger machines which are used in commercial establishments, will be held on April 4-15 and all manufacturers of such equipment have been invited to participate.

The development of the "iceless icebox" has been remarkable during the past decade, particularly for household use. Ten years ago there was only one concern in New York manufacturing an electrically operated household refrigerator, whereas today there are ten with all facilities taxed to meet the demand. In fact electrical refrigeration now receives the same consideration in the planning of the modern home as the electric laundry. In May there will be an exhibition of electric signs, while industrial heating apparatus will be shown in June. After the summer season, lighting fixtures will be displayed in November and electrical household equipment in December.

VERMONT ASSOCIATION TO MEET.

The annual meeting of the Vermont Electrical Association, of which A. B. Marsden, Rutland, Vt., is secretary-treasurer, will be held March 24 at the Hotel Vermont, Burlington, Vt. The program calls for a business meeting in the afternoon, at which new officers will be elected, and a banquet in the evening. The Accident Prevention Committee of the National Electric Light Association will hold a meeting on the above date at the same place.

WESTINGHOUSE VETERANS DINE AND ELECT OFFICERS.

The Veteran Employes' Association of the Westinghouse Electric & Manufacturing Co. held its eighth annual banquet recently in Pittsburgh, there being present 950 members of the Association, which includes in its membership both men and women and now has a roll of over 1200 members. Among others at this meeting were Guy E. Tripp, chairman of the board of directors, Westinghouse Electric & Manufacturing Co.; C. A. Terry, vice-president; Calvert Townley, assistant to president; E. M. Herr, president; H. D. Shute, vice-president; T. P. Gaylord, acting vice-president; J. J. Jackson, attorney, and H. H. Westinghouse, president of the Westinghouse Air Brake Co. The speakers at the meeting were Col. H. G. Prout, who was long associated with George Westinghouse, who told of his associations; and Dr. W. R. Farmer, of the Western Theological Seminary. James McA. Duncan, manager of the Pittsburgh district office, was toastmaster. The new officers elected were R. W. Patton, president; R. L. Wilson, vice-president, and C. W. Hutchinson, trustee.

PROVIDENCE SECTIONS MEET.

"The Electrification of Steam Railroads" was the subject discussed by C. C. Whittaker, Westinghouse Electric & Manufacturing Co., at the joint meeting of the Providence (R. I.) Engineering Society with the local section of the American Institute of Electrical Engineers March 15, the talk being illustrated by lantern slides.

ENGINEERING SOCIETY FORMED IN MONTREAL.

An engineering society has been formed in Montreal by the employes of the Northern Electric Co., the Canadian associate of the Western Electric Co. The inaugural meeting was attended by 150 engineers and draughtsmen, who elected the following officers: P. W. Sise, honorary president; W. Stanley Vipond, president; D. W. Whitney, vice-president; L. E. Hamilton, secretary, and Gordon S. Patterson, treasurer. Repre-

sentatives of each of the branches of the engineering department were elected members of the council. They are: T. J. Heeney, cable branch; W. E. C. Irwin, apparatus branch; N. R. Ashley, inspection branch; W. D. Bishop, commercial power branch, and W. E. Brebner, equipment branch.

CHANGES HEADQUARTERS.

The California Electrical Co-operative Campaign has announced the removal of its headquarters from 619 Call building to 710 Humboldt Bank building, San Francisco. Robert L. Eltringham is executive secretary of the organization.

CANADIAN ASSOCIATION TO MEET.

The annual convention of the Canadian Electrical Association will be held June 15-17 in Quebec City, announcement to this effect having been made by Eugene Vinet, secretary-treasurer of the Association.

PRELIMINARY INJUNCTION ISSUED AGAINST RATE INCREASES.

The Supreme Court of New York has issued a preliminary injunction on application of the city, restraining the New York Edison Co. and the United Electric Light & Power Co. from continuing the increased charge of $0.079 per kw-hr., which became effective in December last, as against a rate of $0.07, as heretofore. The court holds that the lower rate, becoming operative on July 1, 1917, was fixed by a contract; that the contract was still in effect and the increases granted last fall by the Public Service Commission were illegal. The increases permitted by the commission were on a sliding scale to be determined by coal prices, being $0.51 for each 10% increase in the price of coal over the $3 rate of 1917.

HOT CATHODE DEVICES OUTLINED BY DR. DUSHMAN.

The feature of the 236th meeting of the Schenectady (N. Y.) section of the American Institute of Electrical Engineers, held March 18, was an address by Dr. Saul Dushman of the research laboratory, General Electric Co., on "Hot Cathode Devices, Their Principles and Applications." The speaker outlined the electron theory and described the phenomena taking place in hot cathode devices and discussed the principles involved in the Coolidge X-Ray tube, the Kenotron, the Pliotron and more recent devices, all of which have been developed in the research laboratory of the General Electric Co.

NEW YORK SECTION, N. E. L. A., PLANS GALA AFFAIR.

The annual entertainment and dance of the New York Companies' Section of the National Electric Light Association will be held at the Waldorf-Astoria Hotel, New York City, on the evening of March 29. The affair promises to be one of more than local significance. Members of the Philadelphia section's Philadelphia Electric Light Opera Co., or "Peloc" as they prefer to call it, have been invited to present "Mixed Doubles," a musical comedy that has already scored considerable success on several occasions in Philadelphia. Dancing will follow the entertainment features. Among the invited guests who will attend are the officials of the Philadelphia Electric Co., those of the National Electric Light Association and those of the New York companies that comprise the section.

COMING CONVENTIONS.

Wisconsin Electrical Association. Annual convention, Milwaukee, March 22-24, jointly with the Wisconsin Gas Association. Secretary, J. P. Pulliam, 1408 First Wisconsin National Bank building, Milwaukee.

Kansas City Electrical Show. First annual electrical exposition, Convention Hall, Kansas City, Mo., April 18-23. Manager, Sam Furst, Electrical Trades Exposition Co., 802 Broadway, Kansas City, Mo.

American Electrochemical Society. Spring meeting, Atlantic City, N. J., April 21-23. Headquarters, Hotel Chalfonte. Secretary, Joseph W. Richards, Lehigh University, Bethlehem, Pa.

Southwestern Electrical and Gas Association. Annual convention, Galveston, Tex., May 18-21. Headquarters, Hotel Galvez. Secretary, H. S. Cooper, 403 Slaughter building, Dallas, Tex.

American Society of Mechanical Engineers. Spring meeting, Chicago, May 23-26. Headquarters, Congress Hotel. Assistant secretary, C. E. Davies, 29 West 39th street, New York City.

International Railway Fuel Association. Annual convention, Chicago, May 24-26. Headquarters, Hotel Sherman. Secretary, J. G. Crawford, 702 East 51st street, Chicago.

Electrical Supply Jobbers' Association. Thirteenth annual meeting, Hot Springs, Va., May 25-27. Headquarters, The Homestead. General secretary, Franklin Overbagh, 411 South Clinton street, Chicago.

Pacific Coast Geographic Division of the National Electric Light Association. Annual convention, Del Monte, Cal., May 25-27. Headquarters, Hotel Del Monte. Secretary, L. H. Newbert, 445 Sutter street, San Francisco.

National Electrical Light Association. Annual convention, Chicago, May 31-June 3. Headquarters, Drake Hotel. Executive manager, M. H. Aylesworth, 29 West 39th street, New York City.

North Central Electric Association. Annual convention, Duluth, Minn., June 14-16. Secretary, H. E. Young, 15 South Fifth street, Minneapolis, Minn.

Tri-State Water and Light Association. Annual convention, Asheville, N. C., June 15-16. Secretary, W. F. Steiglitz, Columbia, S. C.

National Fire Protection Association. Annual convention, San Francisco, June 14-16. Secretary, Franklin H. Wentworth, 87 Milk street, Boston.

Canadian Electrical Association. Annual convention, Quebec City, June 15-17. Secretary, Eugene Vinet, Power building, Montreal, Que.

American Institute of Electrical Engineers. Annual convention jointly with the Pacific Coast convention, Salt Lake City, Utah, June 20-25. Secretary, F. L. Hutchinson, 33 West 39th street, New York City.

North Central Geographic Division of the National Electric Light Association. Next convention, Duluth, Minn., June 21-23. Headquarters, Spaulding Hotel. Secretary, H. E. Young, 15 South Fifth street, Minneapolis, Minn.

Ohio Electric Light Association. Annual convention, Cedar Point, O., July 12-15. Headquarters, Breaker's Hotel. Secretary, D. L. Gaskill, Greenville, O.

National Association of Electrical Contractors and Dealers, Anniversary convention, Buffalo, N. Y., July 20. Secretary, W. H. Morton, 110 West 40th street, New York City.

COMMERCIAL PRACTICE

New Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

FUNCTIONS OF A PUBLIC UTILITY'S METER DEPARTMENT.

Meter Service and Practice Outlined in Paper Read at District Managers' Meeting of Yakima-Walla Walla (Wash.) Division.

By R. M. Freeman,
Manager, Meter Department, Pacific Power & Light Co.

The meter department concerns itself in general with all work involving electrical measurements, its particular functions being the inspecting, testing and repairing of meter installations. Meter tests are necessary because (1) the public service commissions require them, (2) our own interest demands that they be made, and (3) it is sound policy to make them in order to satisfy customers' complaints.

The Public Service Commission of Washington, in its ratings, requires: (1) That all meters be tested prior to their initial installation; (2) that all meters be tested every 2 yrs.; (3) that any meter shall be tested at the request of the consumer without charge and within 10 days of request, provided such request has not been made previously within a year; (4) that a complete record of meter tests be kept, open to the public, and that all tested meters be tagged showing number, size, date of test, result of test, and name of meter tester; (5) that the commission will test a meter upon request of consumer registered with the company for a fee of $3, this fee to be paid by the company in case the meter is found to be fast beyond the allowable limit of 4% and if not so found to be paid by the consumer; (6) that no meter shall be placed in service or allowed to remain in service which is more than 4% fast or which registers on no load.

The Oregon Public Service Commission requires (1) that we maintain suitable working standards to within 0.5%; (2) that each meter be checked for correct connection, mechanical condition and suitable location, and, if necessary, adjusted to be correct within 0.5% at 10% and 75% of full load; (3) that periodic meter tests be made according to the following schedule: Single phase induction type, 50 amperes and under, once every 3 yrs. Single phase induction type above 50-ampere polyphase of rating 500 volts, 50 amperes and under, and all commutator meters of 500 volts, 50 amperes and under, once every 12 mo. All other meters once every 6 mo. (4) That all meters be tested before being placed in use; (5) that a record be kept of tests, open to the public, including the original tester's record; (6) that all meters be tagged with date and result of test and name of tester; (7) that any meter shall be tested at request of consumer if test has not been made within 1 yr.; (8) that the commission will test meters upon request of consumer under regulations regarding fees similar to those of the Washington commission; (9) that the limit of error shall be 4% and no meter having a greater error or an incorrect register ratio or registering on no load shall remain in service.

These rules are presumably made in the interest of the consumer and for his protection, yet the period prescribed between meter tests in the Washington rules is shorter than necessary to afford the desired protection. Our company with its scattered rural business is put to considerable expense in order to comply with these requirements because of the heavy transportation costs and time lost on the road. By lengthening the period in question the consumer would still be protected and the expense of making the tests would be materially reduced.

Certain conditions make desirable an annual inspection of rural power meters, but it has been found that these conditions can be adequately taken care of by inspection without instruments, requiring a third of the time and involving a third of the expense of making a complete accuracy test. This inspection as distinguished from a test would consist of a survey of the meter installation for the purpose of detecting friction due to dirt, a bad jewel, a corroded or wrongly set top bearing, open potential coils, or burnt-out current coils. With these faults corrected there is slight chance of the meter being off more than the allowable 4%. This system of inspecting was tried out in the Walla Walla territory with excellent results.

Following out the above ideas a schedule for the inspecting and testing of meters has been prepared, which will provide adequate protection for both the customer and the company and yet which will not result in an excessive burden of expense to the company: Single-phase lighting meters on residence and commercial lighting schedules to be tested once every 3 yrs. and inspected annually; power meters, single-phase and polyphase, below 50 amperes, to be tested every 3 yrs. and inspected annually; power meters, 50 amperes and over, and all primary meters to be tested annually.

Even though the periodical testing of meters was not required by the commission, we would still find a certain amount of this testing justified by reason of the added revenue from corrected meters and from the correction of other conditions of the installation which are a source of loss. While a triennial test would probably not show an average error of more than 2%, it is not infrequently that the meter man discovers on large power installations such conditions as open potential coils on polyphase meters, or open potential circuits on primary meters, wrong constants used in billing, or too small a billing connected load or demand, the correction of which may in a single instance pay his salary for a month.

A meter man should be more than a meter

tester; he should see to it that all sources of loss due to conditions discoverable by a careful inspection of the consumers' installations are found and corrected. He should, when testing, make sure not only that the meter is accurate and is left in a condition to maintain its accuracy, but also that all power used is metered and that the consumer is being billed on the proper basis of demand or connected load. Work of this character demands a better all-around man than is required for ordinary routine testing in a large city. With our large number of small branches we cannot maintain such close supervision of our meter men and they are on their own responsibility for a large part of the time. For this reason, therefore, they must be especially conscientious and dependable men.

Value of Meter-Testing in Settling Customers' Complaints.

A third reason for meter testing is its value as an aid to settling customers' complaints. It is seldom that a fast meter is the cause of a high bill, and it is inadvisable to suggest this as a possible explanation when a customer complains, since the idea is already too prevalent among consumers that a fast meter is a common occurrence. A thorough investigation of the consumer's premises is the best way to handle complaints and a meter test is of great value in helping to create in the mind of the consumer the impression that everything is being done to make things right. It is seldom that an investigation reveals anything to justify a change in the bill, although often suggestions are made to the consumer which will lead to greater economy. A spirit of good will and readiness to serve upon the part of the company and carefulness and thoroughness on the part of meter men in making complaint investigations tends to make satisfied customers.

Problems of Meter Department Outlined.

In addition to the work outlined above, the meter department aims to repair meters and demand instruments, and to test and maintain meter instruments and relays in stations and substations. This work presents some problems which are peculiar to this system due to the small size of the branches and their inability to keep meter men permanently employed. For periodic testing at least, a man is required who travels from one branch to another, thus giving rise to added expense and limiting the choice of men. This condition has given rise to the necessity of doing much of our repair work in a single central shop with consequent transportation costs. Another item of cost results from the motor transportation necessary to reach meters in the rural districts.

In the organization of this department we plan to make use of three classes of meter men: Permanently located, full-time men in branches large enough to support them; field men who will visit the other branches in turn to clean up routine testing and make meter inspections; men on the regular force at branches not having full-time meter men, who understand meter testing sufficiently to handle most of the complaint testing, installation of new meters, low-bill testing, some periodic testing and most of the minor repairing.

The permanently located men are the regular employes of the branch and are to be under the direction of the district manager. Monthly reports on regular forms will be required of them and they will be visited and their work checked at regular intervals. A record of their work will be kept and suggestions will be made to the managers by this department as to the conduct of the meter work. The importance of keeping the routine testing up to commission requirements should be emphasized. To do this the meter man must put full time on the job and must make the most of his time; interruptions and delays are to be avoided.

ELECTRIC COMPANY'S POWER BUSINESS SHOWS GAIN.

Chart Demonstrates Rapid Growth of Power Business Served by Minneapolis General Electric Co. From 1915 to 1920.

The annual report of H. E. Young, sales manager of the Minneapolis General Electric Co., contains complete statistics covering the year's operations in every phase of the sales department, with analyses and comparative tables showing increases over previous years and the cost per kilowatt to secure the new business. In 1920 more than 9000 new customers were added to the company's lines and there was a gain of more than 12,000 hp. in power business, the latter including no large single power installation. A total of 6300 ready-built houses were wired during the year, practically all of them on existing lines of the company.

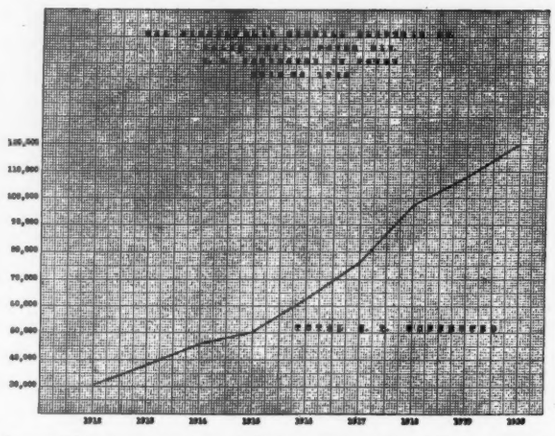


Chart Showing Growth of Power Business of Minneapolis General Electric Co.

Several charts are also contained in the report showing the development of the company during the past 8 yrs., one of the most interesting of which is the accompanying chart showing the growth of the power business served. From a total of 30,000 hp. in 1915 to 120,000 hp. in 1921 is the record of this remarkable development. The curve of growth is almost a straight line, and in commenting on this Mr. Young says: "The present rate of growth of the power business is sufficient to carry this line upward even more rapidly than has been the case at any time in the past. A large amount of power business is awaiting service and it is only necessary to secure the required construction to enable us to serve it."

OPERATING PRACTICE

Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

CENTRAL STATIONS REQUIRE LARGE QUANTITY OF FUEL.

Central stations of the country used 3,013,429 tons of coal and 1,092,998 bbls. of oil in September of last year to produce 2,269,997,000 kw-hrs. of energy. New York produced a greater volume of fuel-generated energy than any other state, Pennsylvania, Ohio and Illinois being next in order. These four states generated with fuel almost as much as all the other states together and about 80% as much as all the hydroelectric energy produced in the entire country.

At this rate of use the central stations of the country will consume about 6% of the entire coal output of the country.

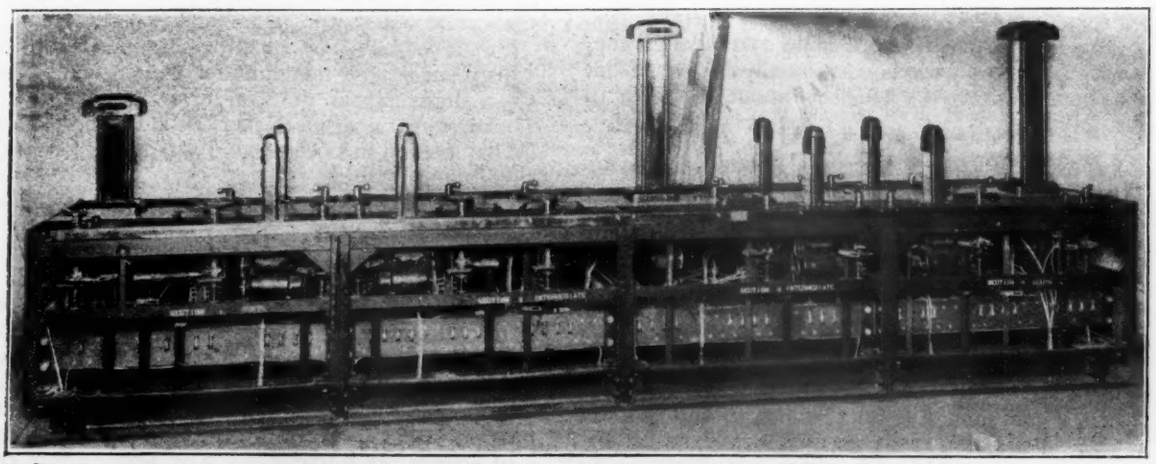
MODEL OF CANAL USED AS CONTROL AND INDICATING BOARD.

Position of Locks, Water Levels and Other Important Operating Features Indicated on Control Board for Guidance of Operators.

An electrical switchboard for controlling the locks of a canal, which is a representation of the actual canal in miniature, has just been worked out by the switchboard engineers of the General Electric Co., Schenectady, N. Y. The control board has been manufactured by that company for the Port Commission of New Orleans, which is building a 6-mi. industrial canal. Quite out of sight of the canal itself one man as operator can control the movements of the lock machinery and see before his eyes just what is happening on the actual canal when he turns the control handles. The system is patterned closely after the central boards built for the Panama canal. The control apparatus there, which is also carried out as a model of the real canal, is working satisfactorily and has attracted a great deal of interest among engineers.

The control board built for the Port Commission of New Orleans will be the first of its kind in the United States, and the only one outside the Panama canal zone. The miniature canal, or control board, is 16.5 ft. in length. In solving the problem of lock control the engineers so designed the switchboard as to show in miniature the actual operation of all main apparatus and also indicate the level of water in the lock chambers and the position of all water valves. The switchboard shows the lock chambers of the canal by a stretch of marble slabs extending from one end to the other of the control board. At various points along the line of this miniature canal columns rise to various heights. These columns are scaled for reading and indicate the rise and fall of water in the lock chambers when the operator, by means of the control handles, opens and closes the water gates in the actual canal.

On the top and near the edges of the board are located the control handles. These handles are operated through an angle of 90 deg. They open and close the circuits to the electrical apparatus which works the lock machinery located in the walls of the locks. Name plates show the "open," "close" and "off" positions of the handles. A special arrangement was worked out to take care of the question of interlocking. A series of vertical and horizontal bars is provided which move in a direction 90 deg. apart. The bars are provided with beveled stops known as "dogs" designed to engage one another. When these dogs meet it is impossible to move one bar until the turning of a control handle has lifted the dog out of the way. Other control handles meanwhile are locked out of action. The advantage of this arrangement is that there is no possibility of an incorrect sequence of control. No handle can be turned out of its proper order so



Switchboard Built as a Model of Actual Canal Operated by Machinery Which It Controls.

that the operator cannot move handle No. 4 before he turns handle No. 3—a proceeding which might empty the water out of a lock while the vessel was still in the lock chamber. The Sylsyn system is used as the medium of indication between the lock machinery and the switchboard.

The canal to be controlled by this system will connect the Mississippi river with Lake Pontchartrain and will eventually provide a shorter water route from New Orleans to the Gulf of Mexico.

STATION AND SERVICE WATT-HOUR METER TESTING.

Classification of Meters and Establishment of Testing Intervals Makes for Efficiency—Instrument Transformers Tested With Meters.

By H. O. Hampson,

Foreman, Meter Department, Nebraska Power Co., Omaha, Neb.

There is little need to go into the reasons for testing watt-hour meters, it being now generally recognized that efficiency of distribution of energy is of great importance, and that such efficiency depends in a large degree upon the accuracy of the watt-hour meters used on the system. These measuring devices have been greatly improved in recent years, but they still are machines and are subject to deterioration. In addition, such equipment is always liable to damage from improper use and accidents. Included among the latter hazards are overloading, short-circuits and lightning.

It is of great importance to select a meter of the proper capacity for each installation. Inaccuracy is more likely to occur on light loads of less than 20% of rated capacity than on loads of from 60 to 150% of full load. It follows, then, that the rated capacity of any watt-hour meter should be adapted to the normal loads of that meter. For instance, a residence may have 30 or more 50-watt lamps connected; but it would be very seldom that every lamp in the house would be used at the same time. The normal number of lamps used would be considerably less than one-half the total, so that a 5-ampere meter would operate most of the time at much nearer its rating than a 15-ampere meter. The same consideration applies to power installations. Efficiency is gained by having meters operate on as near rated capacity as possible even though they may for short periods occasionally be overloaded as much as 100%, which is about the limit of safety.

Importance of Selecting Proper Location for Meter Installation.

Location of watt-hour meters is of no less importance than the selection of meters for size. Vibration will soon injure the brushes and commutators of meters of the commutator type and will likely cause creeping. Moisture or acid fumes will cause rust and corrosion which will in time ruin any meter. Therefore the location of a meter should be on a solid wall and in a dry and clean place, easily accessible without annoyance to occupants and where not likely to be damaged.

Commutator-type meters, used now almost entirely on d-c. circuits, require considerable more attention than induction-type meters. This is due largely to brush and commutator trouble. A slight arcing at the brushes soon roughens the surfaces and causes excessive friction, slowing the movement of the meter on light loads especially. If such a meter after being in service some time shows no roughening of brushes or commutator, it is best to merely clean but not polish the contact surfaces as they will have reached a nearly permanent condition through aging, and the resistance at the points of contact will remain practically constant. Then the accuracy of the meter will be maintained for the maximum time possible when not affected by other conditions.

A rotating standard with portable storage cells and a carbon rheostat makes a convenient outfit for testing d-c. watt-hour meters, especially those of from 25 to 150-ampere capacity. For smaller meters used on lighting circuits a resistance load box is more convenient than storage cells, but for all meters used on more than 250 volts the storage cells are better and take no current from the line. Direct-current meters of over 150-ampere capacity are usually tested with indicating instruments and a stop watch, using the actual load on the system served.

Induction-type meters of all capacities can be tested with rotating standards, using resistance load boxes or transformers giving a variable low-voltage current. Current and potential transformers used with watt-hour meters should be tested whenever there is reason to think that they may have been damaged by lightning, opening the secondaries of current transformers, or other causes. When not abused the accuracy of transformers is practically permanent, and tests at from 7 to 10-yr. periods should be sufficient.

Testing Meters Used in Connection With Instrument Transformers.

Meters used with transformers can be tested separately as 5-ampere meters, but sometimes it is advisable to test a meter and its transformers as a unit. In such a case standard current transformers are connected in series with the meter current transformers, standard potential transformers are connected in multiple with the meter potential transformers, and a rotating standard is connected to the secondaries of the standard transformers. The resulting check permits adjustment of the meter under test to compensate for slight errors in transformers, or shows at once when a transformer should be replaced. This method has been found satisfactory for testing station meters.

It is well to classify meters as to type and amount of energy registered by each, those in each class being tested at definite predetermined intervals. The length of these intervals will be largely a matter of opinion, but it is safe to say that all commutator-type meters should be tested at least once every 18 mo. and all induction-type meters at least once every 4 yrs. From these maximum periods the intervals can be graduated so that meters registering large amounts of energy are tested every 2 or 3 mo. where considered necessary.

APPLIANCES and DEVELOPMENTS

New, Improved or Interesting Electrical and Mechanical Apparatus and Devices, and Applications of Equipment and Methods in Practice

Automatic Feed-Water Regulators for Steam Boilers.

The first efforts in boiler feed regulation aimed at keeping the water level in the boiler as nearly constant as possible. Later it was realized that keeping the water level constant at all times had decided disadvantages. Prior to that time automatic boiler-feed regulation depended on a combination of floats, pilot valves, diaphragms, springs,

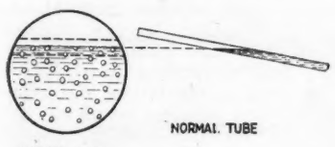


FIG 1

Diagram Showing Normal Boiler Conditions and Normal Regulator Tube.

etc., which would open the feed-water valve until a certain maximum water level had been reached in the boiler, and then would close it until a certain lowest limit in the water level had again been reached. This gave an irregular intermittent feed but represented an improvement over hand regulation. While an automatic mechanical device that is absolutely reliable has never been made, there are many automatic mechanical devices which are far more reliable than a human being, especially where the apparatus is given a reasonable amount of care and attention. It is for this reason that a properly designed water regulator will add much to the safety of an operating plant.

A continuous flow of feed water with gradual variations in rate saves the boilers, heaters, economizers, meters, water pumps, piping, and all connection from shocks and strains due to violent and extreme fluctuations in the rate of feed-water flow peculiar to many forms of old-style regulators. The continuous flow also makes possible the use of smaller feed pumps, feed-water pipe lines, connections, valves, etc., because when the feed-water supply is continuous the rate of flow at any given time need not be as great as when water is fed intermittently. As the equipment in boiler rooms became more and more involved with the addition of water softeners, economizers, feed-water heaters, superheaters, temperature, steam and water meters and recorders, and other apparatus to promote economy and efficiency in the generation of steam, it became evident that the rate of flow of feed water had a decided effect on the efficiency of all of this equipment and on the legibility of the charts produced by the various recording meters.

A water softener is designed to handle a certain number of gallons of water per hour on the basis of a continuous even flow. Where the flow is intermittent and irregular a much larger water softener must be installed to handle the same quantity of water, and its operation is far less satisfactory and economical than it would be if the flow of feed water were continuous and more closely in unison with the rate of steam output of the boiler. The same is true of economizers and feed-water heaters. When the flow of feed water through these is reduced the feed water reaches an excessively high temperature and may even turn into steam, resulting in water hammer and other troubles in the feed-water system. The apparatus under these conditions allows heat to escape without being absorbed. On the other hand, when at intervals the feed-water valve is opened wide the feed water may rush through at such a high rate that it is not warmed up to a temperature commensurate with economical boiler operation.

The rate of feed-water flow has a decided effect upon the steaming capacity

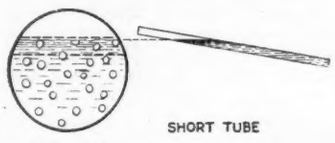


FIG.2

Diagram Showing Peak Boiler Load and Short Regulator Tube.

of a boiler itself. A full opening of the feed-water valve may pass enough cold water into the boiler to absorb all the heat generated by its furnace without generating any steam whatsoever. Intermediate rates of flow will, of course, reduce the steaming capacity of a boiler in proportion. Bearing this in mind it is evident that there are frequent periods in the operation of a steam boiler when it would be desirable to reduce the rate of feed-water flow so as to make possible the maximum generation of steam. This is particularly true after a period of low load when a sudden peak load comes on. Under these conditions the furnace must be given time to catch up with the new load conditions, and if, during this time, the rate of feed-water flow is temporarily reduced, the boiler has a far better chance to meet the sudden increased demand for steam when little heat is being consumed in heating feed water to the boiling point in the boiler itself.

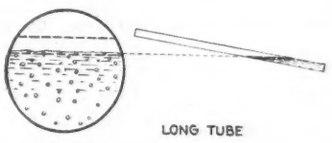
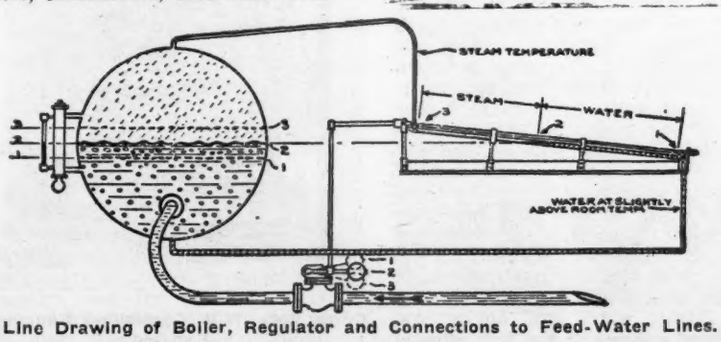


FIG.3

Diagram Showing Low Boiler Load and Long Regulator Tube.

On the other hand, should the load suddenly drop off after a high load period it takes some time for the furnace to slow down to where it generates heat at a rate in harmony with new load conditions. It is then desirable to increase the rate of feed-water flow temporarily so as to absorb the extra heat generated by the furnace during this brief period. Again, where a large number of boilers are acting in unison, fewer boilers can be made to do the same work which would ordinarily require a larger number of boilers without scientific feed-water regulation. With unscientific feed-water regulation the steam output of some of the boilers may be so affected by the admission of feed water during a high-load crisis that their addition to the total steam supply is much curtailed, or even reduced to zero, when it is most needed. With proper regulation all the boilers would be delivering their maximum output, the rate of feed-water flow being reduced to a minimum in all of them at the same time to make this possible.

A good automatic feed-water regulator should, then, feed continuously as long as there is a load on the boiler. It should temporarily reduce the rate of feed-water flow when there is a sudden increase in load and temporarily increase the rate of flow when there is a sudden decrease in load. It should keep the water level high under low loads and low under high loads. During steady loads it should maintain a constant water level by maintaining a constant rate of feed proportionate to the load, and during gradual changes in the load it should gradually adjust the rate of feed in proportion to the changes in the boiler load. A regulator functioning on these principles acts as a compensating boiler governor; that is, it supplies the means of absorbing the excess heat generated by the furnace



Line Drawing of Boiler, Regulator and Connections to Feed-Water Lines.

during the brief period following a sudden falling off of the load when the furnace has not yet had time to adjust itself to the new conditions. It prevents the undue absorption of heat by the feed water when the furnace has not yet had time to catch up with a sudden increase in load. It utilizes the volume represented by the difference in the levels of the water between the high and low-water marks in the boiler as a heat reservoir, and so regulates the water level as to insure dry steam at all times. It guards against damage due to too-high or too-low water level at any time.

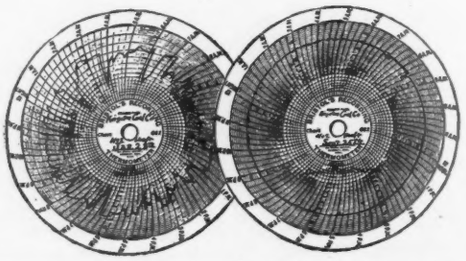
It has been found that the water level of a steaming boiler undergoes pronounced fluctuations which have a direct relation to the rate at which it is producing steam. This is due to the increased volume of steam bubbles present in the water when the steam output of the boiler is high. Accompanying illustrations show the variations in the water level in a steam boiler containing the same weight of water under normal, peak and low-load conditions. This variation of water level according to load is one of the characteristics of steam boilers utilized in the Copes regulators shown in one of the accompanying illustrations. A regulator of this construction is extremely simple, consisting merely of a straight tube, a lever, a heavy iron base, and a balanced and practically frictionless valve. Such a regulator is said to be easily adjusted to maintain the water level between any desired limits. The connections to the boiler, as shown in the line diagram, are quite simple.

Copes Boiler-Feed Regulator, Showing Tube, Valve and Counterweight.

In this feed water regulator a metal tube having a large coefficient of expansion is connected to the boiler in such a way that the level of the water in this tube varies with the level of the water in the boiler. The water in the lower end of the tube, not being exposed to any source of heat, becomes comparatively cool, while the upper end of the tube above the water level is kept hot by steam from the boiler to which it is connected. As steam slowly condenses in the upper part of the tube it is returned to the boiler through the lower end. If the water level in the boiler suddenly rises due to an increase in load, the level of the water in the tube also rises and the length of the tube above water containing hot steam is reduced. If, on the other hand, there is a dropping off of the water level due to a decrease in load the length of the tube exposed to hot steam is increased by the amount the water level recedes in the tube. The portion of the tube which is exposed to the hot steam expands—the greater the length that is so exposed the greater the increase in the overall length of the tube. This difference in the overall length of the tube between high or low water is utilized to operate a valve which controls the rate of flow of the feed water.

When there is a sudden increase in the demand for steam the water level in the boiler rises. The length of the tube exposed to the hot steam is decreased and the length exposed to the cooler water is increased. Consequently there is a contraction, and the overall length of the tube is decreased and this in turn reduces the opening of the feed water valve. If the high load continues, the level of the water will, of course, gradually drop off until the water level in the tube comes to a point where the feed water valve again begins to open. The opening increases gradually until a uniform rate of feed is reached, which is equivalent to the rate at which the water is used in making steam. If the demand for steam is high the demand for feed water is high, and the feed-water valve must have a wide opening. To get this the tube must expand more. This in turn can only be brought about by a lower water level, and that is exactly what is desired under high-load conditions.

If, on the other hand, the demand for steam suddenly drops off after a continuous high load the water level in the boiler falls immediately, and with it the level of the water in the tube. The length of the tube exposed to hot live steam is increased, causing an increase in its overall length. This in turn opens the feed-water valve so as to admit water to the boiler at a greatly increased rate until not only the former level is reached, but until the level is higher than the one under high-load conditions. To reduce the flow of feed water to conform to the reduced demand for steam the opening of the feed-water valve must be reduced to less than it was when the demand for steam was high, and to accomplish this the thermostatic tube must contract more. It does this only with a rise in the water level. Higher water level during low loads is very desirable for heat storage purposes as explained before, and is entirely permissible with light loads.



Feed-Water Temperature Charts, Showing Effect of Good Regulation on Feed-Water Temperature.

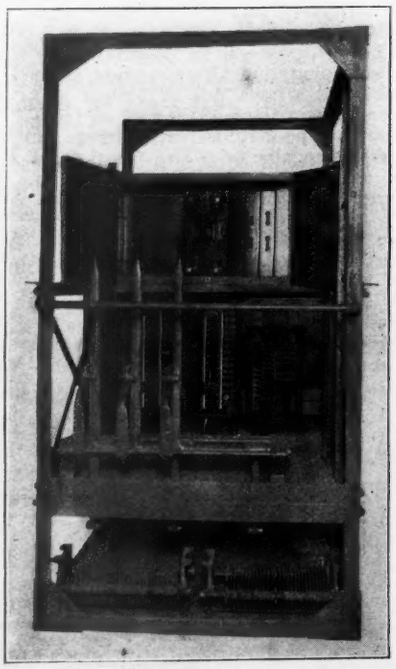
The two time-temperature charts shown in an accompanying illustration are typical before-and-after records where one of these automatic thermostatic boiler-feed regulators replaced hand regulation. The left-hand diagram shows an average feed-water temperature of 178 deg. F., which was the best obtainable with hand regulation. The right-hand diagram shows an average feed-water temperature of 210 deg. F., which resulted with automatic continuous-flow regulation based on the principle here set forth. The average feed-water temperature was therefore increased 32 deg F., which is equivalent to a saving of 3% in fuel.

Pittsburgh Radio Telephone Heard in Arizona.

Word has been received from Meade W. Powell, Warren, Ariz., a distance of 1600 mi. from East Pittsburgh, Pa., to the effect that he receives clearly every night, the entertainments sent out from the experimental wireless telephone station of the Westinghouse Electric & Manufacturing Co. This is the farthest distance from which a report has been received at East Pittsburgh of hearing the program, which is sent out each night from the experimental station.

New Type of "P. & H." Crane Cab.

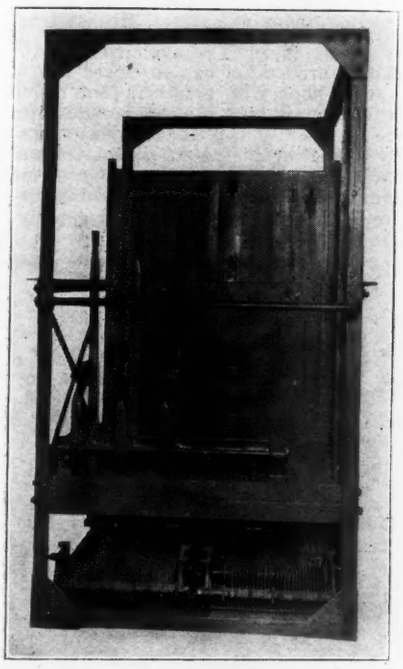
During the 37 yrs. of its manufacture of cranes the Pawling & Harnischfeger Co. of Milwaukee, has naturally kept pace with crane requirements, making developments, adding refinements, standardizing, etc., and this new safety cage is the result of this effort. Space is always at a premium in crane cabs and for this reason exposed knife switches, magnetic control parts and resistors, introduce a serious hazard. In previous "P. & H." crane cages a false bottom in the cab was provided for the re-



Crane Cage With Controlling Equipment Exposed.

sistors greatly simplifying the upper part, but now by providing front lever control also, and placing the entire controller equipment and current carrying parts in an inclosure a maximum of safety is provided. The levers which operate radially (backward and forward) are placed at the front of the cage and allow the operator to have an entirely unobstructed view. He can see the position and movement of the crane hook, the signals of floor men, and the entire floor as the crane travels along the runway. Many crane operators prefer the radial motion of control levers to the coffee-mill movement previously employed.

The crane operator can by no chance come in contact with live parts, even the main knife switch being operated from the exterior of the cabinet by means of the handle shown near the top



Crane Cage With Controlling Equipment Closed.

of right hand door in the illustration depicting the crane cage with controlling equipment closed. As will be noted in the other illustration everything is readily accessible. Opening the hinged doors exposes all parts for inspection and adjustment. The usual covers on the controllers are not needed since the steel cabinet thoroughly incloses the entire equipment. The rear-of-board wiring is accessible by the removal of an inclosing panel at the rear. This new cage has been in operation on a number of cranes and the performance watched for the past year before standardizing.

Supports for Heavy Alternating-Current Conductors.

The adaptability of alternating current to varying conditions, and the simplicity and low maintenance of alternating-current motors compared to direct-current motors, has led to the general adoption of alternating current for industrial plant work. In the moderate and large-size plants with secondary distribution at 220 to 440 volts, currents of considerable magnitude have to be carried, and this condition has brought forth the problem of overcoming the skin effect or mutual inductance caused by such currents. On account of skin effect a copper tube has generally been conceded to be the ideal shape for an alternating-current conductor. However, a copper tube of sufficient size to carry 5000, 8000 or 10,000 amperes is so large and hard to handle that rectangular copper bars have been used on numerous installations of this kind. The use of copper bars stacked in the conventional manner has made it necessary to use a large amount of copper, as the outer bars of the stack carry much of the current. Consequently, the unit current density over all the bars is sometimes very low.

The supports made by the Electrical Engineers Equipment Co., Chicago, have been designed to carry rectangular copper bars in the form of a hollow square or in a manner which approximates copper-tube conditions. All the clamping parts are made of nonmagnetic metal. With bars carried in this manner the skin effect is said to be reduced to a minimum, the bus is properly ventilated, and the current density in all bars is approximately uniform.

Another difficulty which has to be overcome in installations of this kind is the destructive effect of short-circuits. Copper bars carrying large amounts of power under short-circuit conditions will exert tremendous mechanical stresses. Unless the supports are exceptionally strong severe short-circuits on the system will tend to wreck the bus structure. Supports made by this company have been designed to withstand the strain caused by these conditions and still provide a factor of safety. Insulating spacers are clamped in between the different phases of the bus, thus giving added rigidity to the structure.

While the supports have been standardized it is generally acknowledged that there are local conditions affecting each installation which require an engineering study. The engineers of the company confer with prospective users regarding the application of these supports to their particular requirements in order to be sure that suitable devices are selected.

A Portable Scoop Conveyor for Bulk Materials.

It is almost a truism to say that, in order to secure economical operation and maximum efficiency in handling bulk materials, labor must be supplanted by machinery. It is indeed an old story that the man with the wheelbarrow has been supplanted, in large operations like the loading of ships with ore and similar cargoes, by the machine that handles tons of material continuously with giant scoops and belt conveyors. But the adaptation of these instrumentalities to small-scale tasks is not always a simple matter, and it is not always obvious that it can be done at all.

Still, the man with the shovel and the wheelbarrow is expensive and industry, be it small or large, will prosper in proportion with the extent to which it does away with him. Some of the old-style fixed conveyors required hand labor in shoveling the material up into the receiving hoppers, a circumstance which at times limited the advantage derived from their installation.

A new style of portable conveyor for small-scale work, which, it is said, cuts in half the labor of feeding the larger conveyors, and does many other small jobs, is being made by the Portable Machinery Co., Passaic, N. J. The distinctive feature of this machine, and the one which gives it the name of "scoop conveyor," is the scoop on the feeding end. This scoop can be pushed into the material to be conveyed, even to the point of actually burying it therein, if necessary. This makes it possible simply to scrape the material to be carried onto the belt instead of lifting it by shovelfuls or barrowfuls into the feeding hopper. This feature, combined with the portable-conveyor idea, which is not in itself any longer a novelty, insures that however short be the distance through which material has to be transferred from one conveyor to another, from resting place to conveyor, etc., there will be a machine to do it, and the man with the wheelbarrow and the hand scoop will not have to waste his time and his employer's money doing such work by primitive methods.

Another valuable feature of these conveyors lies in the structure of the conveyor sides, or skirt plates, as they are called. These form a trough which makes it possible for a belt of only 12-

Series of Three Conveyors Being Used to Build Up a Pile of Storage Coal.

in. width to equal the carrying capacity of an ordinary 20-in. belt, according to the claims made. The side plates give the entire width of the belt the same carrying effectiveness as the center. It is just the difference between a natural stream, sloping up gradually to the surface along its banks and a cut canal with its perpendicular banks. In the latter case the stream maintains its maximum depth up to the bank on either side, while in the former instance the deep water occupies but a narrow strip in the center of the waterway. The side plates also give an increase in the height to which a conveyor of given length can be made to carry material.

It is more or less of an old story to point out that the use of a properly designed conveyor not only saves direct labor charges, but results in a speeding up of the work itself. Two men with a conveyor will do the work of from four to 12 men, depending upon conditions; and in addition there is the advantage that a given truck will be loaded in from one-quarter to one-sixth the time required by shovelers. So the driver of the truck spends less time waiting for his load and the truck earns its upkeep quicker and pays a better profit. It is the same idea that makes it possible to use a motor truck as a locomotive exclusively, hauling trailers which carry the load while the truck itself goes unloaded and saves money for its owner because of the vastly greater number of trips that it can make in a given time. Still another item of no mean value is the fact that the available storage space is increased by enabling the workmen to pile higher in a given shed or yard.

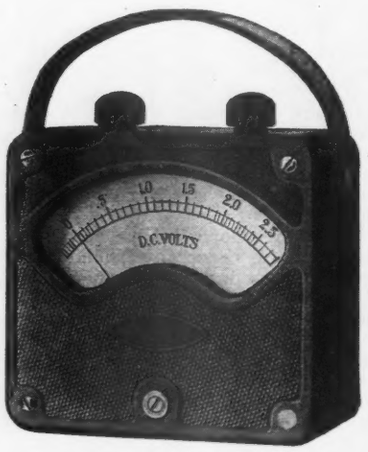
The carrying capacity of the 12-in. scoop conveyor, based on handling coal, is 1 ton per min., provided the supply of material at the receiving end of the machine can be kept up to this rate. It is said that if the storage pile is of sufficient height one man can easily approach this maximum to the extent of feeding 1 ton in 1.5 min., otherwise he may require from 2 to 4 min. Where speed is the prime consideration it can be attained by assigning two men to the work of loading the conveyor. In delivering loads from hopper-bottom cars to trucks there is no question of the supply of material at the feeding end of the conveyor, and the extreme speed of 1 ton per min. can be maintained without difficulty with one man to attend to the loading end of the apparatus.

Perhaps it will not be superfluous to point out explicitly that the leading role of the scoop conveyor is in the storing, reclaiming and loading of bulk materials and light articles. No limit can be set to the different applications which may be made of the machine; it is available for elevating material to tanks or platforms in chemical and industrial works, for feeding from cars and delivery from or into fixed convevors or stoker magazines at power plants, and for a great variety of other purposes. Practically anything can be handled by it—coal of all varieties, ashes, sand, earth, crushed stone, blast-furnace slag, ore, fertilizer, salt, chemicals, loose or sacked grain, light packages, etc. It may be used singly, in tandem or in triplicate as required, and under this head the scoop feature enjoys perhaps its greatest advantage. A detail that is designed to simplify the feeding of the material onto the convevor multiplies its utility by the number of convevors onto which it is necessary to feed the material before it reaches its final destination; so with the scoop conveyor things can be done that would not be practical without it.

The conveyors shown in the illustration are owned and used by the Atlantic Coast Electric Railway Co., Asbury Park, N. J. In commenting on this equipment an official of the company has been quoted substantially as follows: "The pile of coal shown contains about 3000 tons, and we are able to store on this pile 350 tons a day with four men unloading and attending the conveyors. We have had the pile of coal built up four different times in the last two years and removed to the station by the aid of this apparatus, when it would have been impossible to have done this work without this device. We also have at the other end of the plant a similar pile handled by these machines. Previous to acquiring the conveyors it required 30 men to unload and store coal, but we were not able to get anything like the amount in the pile covering the same area. We also use them for unloading broken stone at times."

Portable Instruments for General Testing Purposes.

The type PX portable instruments, manufactured by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., are direct-reading instruments for general testing purposes. These instruments are handy and serviceable and have a wide application for



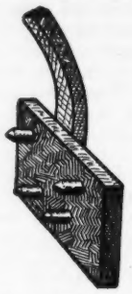
Type PX Portable Instruments.

central-station analysis tests, trade school, high school and college equipment tests, and radio apparatus tests. These instruments are particularly adapted for automobile and battery testing.

The movements are made very light, assuring minimum pivot and jewel wear, and no injurious effects from shock or vibration. The cases are made of molded composition, which is exceedingly strong and acid resisting. The complete movement is mounted as a unit and is readily removed for repairs by taking off the cover and removing the four corner posts. This releases the sub-base upon which all parts are assembled. All parts are easily accessible after the sub-base, with movement assembled, has been removed from the case. The instrument will withstand shocks equivalent to those received in actual services without fear of possible injury.

Cant Hook for Use on Concrete Poles.

The ordinary cant hook used for wooden poles is decidedly unhandy on concrete ones. The single prong often chips out a large piece and has occasionally caused the ruin of a new pole. To obviate this disadvantage one of the



New Type of Cant Hook.

member companies of the Utilities Mutual Insurance Co. has developed a new type of hook with a special foot. This has four teeth set into the face plate in the manner shown in the illustration. By increasing the points of contact and extending the strain on the concrete over a distance of about 6 ins. this de-

Illustrating Use of New Type of Cant Hook.

vice, it is said, will handle even the softest "green" pole without damage and without the risk of dropping the concrete unexpectedly. The hook is the invention of Mr. Jennyjohn, of the Rochester (N. Y.) Gas & Electric Corp., who is shown in the accompanying illustration using his own instrument.

An examination of the special foot of the Jennyjohn cant hook in the accompanying illustration discloses the short but solidly studded teeth which are intended to grip without fracturing the cement pole.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Wireless Specialty Apparatus Co., New York City, has filed notice of reduction in its capital stock from $700,000 to $492,000.

Pruitt-Deming Manufacturing Co., Edinburg, Ind., plans to erect a factory for the manufacture of storage-battery equipment.

Connecticut Electric Manufacturing Co., Bridgeport, Conn., has filed notice of increase in its capital stock from $200,000 to $450,000.

Price Gas & Electric Supply Co., 38 North Ninth street, Philadelphia, has filed plans for extensions and improvements in its building to cost about $10,000.

National Lamp Works of General Electric Co. plans to erect a plant at New Albany, Ind., for the manufacture of electric lamps, at an estimated cost of $1,000,000.

Regina Co., Rahway, N. J., has prepared for the use of the dealer attractive two-color descriptive folders on the new models of the "Regina" electric vacuum cleaner.

Sterling Storage Battery Co., Schenectady, N. Y., manufacturer of electrical equipment, has filed notice of reorganization with an active capital of $55,000 and $50,000 in preferred stock.

Mid-State Battery Manufacturing Co., of which M. J. O'Connor is president, 615 West Grand street, Oklahoma City, Okla., plans to establish a plant for the manufacture of storage batteries, etc.

H. A. Graves and H. Etchells have recently been granted a new patent on a 3-electrode electric-melting furnace. These patents are controlled by the Electric Furnace Construction Co., Philadelphia.

Reliance Weighing Machine Co. (formerly the Reliance Automatic Scale Co. and previous to that the National Automatic Scale Co.) has moved its general offices and factory from Chicago to Ludington, Mich.

Cutler-Hammer Manufacturing Co., Milwaukee, has transferred its clutch and magnet department from the main works in Milwaukee to the plant shown in the illustration, which is located in West Allis, about 7 mi. from the Milwaukee works. The move has allowed the expansion of some of the other departments at the main plant, and has given the clutch and magnet department the necessary room and equipment to meet the increased production required. The new plant was erected during 1917 and 1918 by the Wisconsin Gun Co. for the manufacture of guns for the U. S. Government. The building housing the shops and office is 300 by 300 ft., and has been equipped with machine tools and winding machines for the manufacture of the department's various products, including the electric shoe brakes, lifting magnets, magnetic clutches, clutch-brakes; magnetically operated navy disc brakes for hoists, windlasses, etc.; hold-down magnets for plate shears, and magnetic separator pulleys. A portion of the plant is devoted to the making of punchings for the motor controllers put out by the main plant in Milwaukee. This branch plant employs between 250 and 300, and maintains a cafeteria and hospital on the grounds for the benefit of the employes. E. T. Foote, formerly of the engineering department at the main works and later manager of the Boston district office, is manager of the plant.

New Branch Plant of Cutler-Hammer Manufacturing Co. Occupied by Clutch and Magnet Department.

Sampson Manufacturing Co., 4244 West Lake street, Chicago, manufacturer of electric fixtures, etc., has completed plans for a 1-story plant on West Lake street to replace the one recently destroyed by fire.

Electric Furnace Construction Co., 908 Chestnut street, Philadelphia, has announced that it has closed a contract for a large electric heat-treating furnace with the Yale & Towne Manufacturing Co., Stamford, Conn.

Maring Wire Co., Muskegon, Mich., manufacturer of enameled, cotton and silk-covered magnet wire, has announced the appointment of Harry S. Simpson, 904 Westminster building, Chicago, as its sales representative for the Chicago territory.

Colonial Chandelier Works, 122 Centre street, New York City, reports its factory operating to maximum capacity on account of the demand for its "6000 Colonial Style" lighting fixtures. To meet the anticipated future requirements, alterations and extensions now being made in the plant will increase its output about 100%.

Machado Turbine Corp., 111 Broadway, New York City, recently organized under Delaware laws with a capital of $1,000,000, is planning the establishment of a plant for the manufacture of a special reversible turbine. Pedreira Machado is head of the company.

Fletcher Manufacturing Co., Dayton, O., manufacturer of electrical construction supplies, which has been operating for several years as a partnership, has recently incorporated with a capital stock of $40,000. The incorporators are J. R. Fletcher and R. M. Razoor.

American Insulator Corp., New Freedom, Pa., has announced the appointment of G. L. MacGillivray & Co., Ltd., 103 Notre Dame street, West, Montreal, Que., as its exclusive sales representatives in eastern Canada to handle the "Aico" line of products, consisting of cold-molded insulating parts for electrical and automotive units.

Griscom-Russell Co., 90 West street, New York City, has published a 29-page illustrated booklet entitled "The Cooling of Quenching Oil in the Heat Treatment of Steel," by Kenneth B. Millett. This describes in a readable manner the necessity for heat treatment, the various quenching mediums and systems commonly used, the advantages of continuous circulation of the medium and the adaptability of the "Multiwhirl" cooler to the cooling of quenching oil. Typical installations are featured, showing the layout of the piping, with recommendations for the proper size and number of coolers to meet the requirements.

United States Rubber Co., Ltd., 1790 Broadway, New York City, has announced that it is the distributing unit for all products of the United States Rubber Co. in foreign countries. Progress is being made in the wide distribution of its line of rubber insulated wire and cable, weatherproof and barb wire. A full line of electrical conductors, including friction and rubber splicing tape, are among its commodities. Branches carrying ample stocks are being established from time to time. At the present time the following branches carry stocks of wire and tape: Havana, Rio de Janeiro, Montevideo, Buenos Aires, Santiago de Chile, Manila, London, Madrid and Johannesburg. Exclusive distributing arrangements are maintained at several other points in the foreign field where ample stocks are carried, including Mexico, Venezuela, Porto Rico, Barbados, Peru, Colombia, Bolivia and India. "Paracore" wire and cable have now been widely distributed for a period of over 4 yrs., and are meeting with growing success in competition with foreign made wires. The export company's wire and tape department is in charge of H. C. Morehouse.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

RALPH D. MERSHON, consulting and mechanical engineer, has moved his New York City offices to 143 Liberty street.

H. R. SEARING has accepted a position with the United Electric Light & Power Co., 130 East 15th street, New York City.

ROBERT C. WELLER has been appointed general sales manager of the Lakewood Engineering Co., with headquarters in Cleveland.

GEORGE THOMAS has been appointed assistant treasurer of the Stanley Insulating Co., Great Barrington, Mass., to succeed E. J. Slattery.

O. H. HUTCHINGS, manager of the Dayton (O.) Power & Light Co., recently returned from an extended trip through the South and California.

R. E. BROWN, manager of the Mankato (Minn.) division of the Northern States Power Co., is enjoying a vacation in Mexico and the southwestern part of the United States.

FREDERICK T. LOHR, formerly connected with the New York Pyrites Co., Gouverneur, N. Y., is now electrical engineer of the Soper-Mitchell Coal Co., Morgantown, W. Va.

A. S. BALDWIN has resigned as manager and chief engineer of the Poole Engineering & Machine Co., Baltimore. He was formerly manager of one of the Westinghouse plants in Pittsburgh.

FRED G. SINGER, who has been a student engineer with the General Electric Co., has accepted a position as instructor in electrical engineering at the University of Wisconsin, Madison.

M. D. GOODMAN, formerly connected with the Electric Controller & Manufacturing Co., has established offices at 1391 Commonwealth avenue, Boston, where he will specialize in material-handling equipment.

JOHN S. LLOYD, Harrisburg, Pa., for the past 1.5 yrs. assistant traffic superintendent for the Bell Telephone Co. in that district, has been transferred to Johnstown, Pa., where he will engage in a similar capacity for the company.

CHARLES W. ACKERMAN, Joliet, Ill., has been appointed assistant secretary of the Illinois Public Utilities Commission to succeed A. M. Evans, who has resigned to accept a secretarial position with Congressman Frank H. Funk of Illinois.

FRED V. SAMS has been transferred from the engineering staff of the sales department of the Allis-Chalmers Manufacturing Co., Milwaukee, and assigned to the Pacific Northwest territory as sales engineer attached to the branch office at Seattle, Wash.

WILLIAM C. DICKERMAN, vice-president in charge of operations of the American Car & Foundry Co., New York City, has been elected a director of the United Gas Improvement Co., Philadelphia, to succeed Thomas J. Dolan, who has resigned.

P. A. MEYER, General Electric Co., gave an address March 8 before the members of the Washington (D. C.) section of the American Institute of Electrical Engineers on the subject of electric furnaces and electric heating apparatus.

DR. IRVING LANGMUIR, assistant director of the General Electric Co. research laboratory, was recently presented by the American Academy of Arts and Sciences in Boston with the

Dr. I. Langmuir.

Rumford medal given by Count Rumford for distinguished service in the investigation of phenomena of light and heat. Dr. Langmuir's research in thermomic and allied phenomena resulted in his being awarded this honor, in reply to the presentation of which he read a paper on "Phenomena Conditions With the Passage of Electricity Through High Vacuum." Dr. Langmuir is principally known for his development of the gas-filled lamp and for original studies of the structure of matter. Last year he received the William H. Nicholas medal from the American Chemical Society. Dr. Langmuir was born in Brooklyn, N. Y., in 1881 and graduated from Columbia University, later taking a degree at the University of Gottingen, Germany. He formerly taught at the Pratt Institute, Brooklyn, and at the Stevens Institute of Technology.

W. V. LOVELL, who was recently appointed assistant to W. J. Canada, head of the engineering department of the National Electric Light Association, is a graduate of the Georgia Technical School, class of 1915, where he received the degree of B. S. in electrical engineering. After leaving school Mr. Lovell entered the service of the Westinghouse Electric & Manufacturing Co., where he remained until 1917. In May of that year he resigned and entered the Engineers' Corps of the Reserve Officers Training Corps at Fort Niagara, N. Y., and in July of the same year entered the U. S. School of Military Aeronautics at Cornell, N. Y., He served in France with the American Expeditionary Forces and received a commission as first lieutenant in the Twenty-second Aero Squadron. In July, 1919, Mr. Lovell returned to the United States and in August of the same year became connected with the engineering department of the Georgia Railway & Power Co., Atlanta, Ga., resigning from that company in January of this year to accept a position with the N. E. L. A. Mr. Lovell is an associate member of the American Institute of Electrical Engineers and the American Physical Society, and is also a member of the London Mathematical Society.

OBITUARY.

WILLIAM U. FAIRBAIRN, mechanical engineer, formerly connected with the Corliss Steam Engine Co. and the Hartford Steam Boiler Co., died recently in Weston, Mass., in his 88th year. He was a native of Glasgow, Scotland, and came to this country when 9 yrs. old.

ERNEST LAUDERBACH, assistant sales manager of the Bussmann Manufacturing Co., St. Louis, died last month at the age of 39 yrs. He became connected with the "Buss" organization in 1918 and his natural gift for making every buyer a friend made him unusually successful in merchandising "Buss" products.

FRANCIS R. UPTON, former associate of Thomas A. Edison, and first president of the Edison Pioneers—men who worked with Mr. Edison in the early days of the inventor's great successes—died March 10 at his home in Orange, N. J. When Mr. Edison was informed of the death he spoke feelingly of their long association and continuing said: "Mr. Upton was one of my old Pioneers. He was a loyal worker and as a mathematician he assisted me in working out the complicated problems as to economy and adaptability of the devices necessary to make a complete system of electric light by incandescence. He was a very fine man. I am sorry to learn he has passed on." Mr. Upton was the last of the "Big Four", who were associated with Mr. Edison. The other three were Charles A. Batchelor, mechanical engineer; John Kruesi, chief of production, and Edward H. Johnson, business executor. In this association he was also interested in ore milling, quarries and selling materials for concrete construction. Mr. Upton was born in Peabody, Mass., July 26, 1852, of American ancestry dating back over 150 yrs. He was educated in Phillips Academy, Andover; Chauncey Hall, Boston; Bowdoin College, Princeton and Berlin Universities, and from the beginning of his business career showed keen interest in manufacturing problems. A widow, three daughters and two sons survive him.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Otter Cliff, Me.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has completed plans for the installation of an electrical distributing system at the local naval properties.

Patten, Me.—The Katahdin Electric Co., recently organized, is planning the construction of a transmission line from Patten to Houlton, with local distributing lines at different points for light and power service for different municipalities.

Boston, Mass.—The Boston Insulated Wire Co., 65 Bay street, has filed plans for improvements in its power house.

Framingham, Mass. — Electrical equipment will be installed in the proposed 4-story extension to be constructed at the plant of the Dennison Manufacturing Co., manufacturer of paper products.

Natick, Mass.—Considerable electrical equipment will be installed in the 3-story shoe manufacturing plant to be erected by C. W. Dean & Co., North Main street. It is estimated to cost about $100,000.

Worcester, Mass.—The board of directors of the Worcester State Hospital is planning the construction of a cold storage plant at the institution to cost about $50,000. Considerable electrical equipment will be installed.

Providence, R. I.—The United Electric Railways Co. is planning extensions and improvements in its power plant on Manchester street, to cost about $500,000. The plant will be remodeled and new machinery installed. The company is also planning substation extensions and line betterments.

Buffalo, N. Y.—The Lower Niagara River Power & Water Co. has been granted a preliminary permit by the Board of Federal Water Power Commissioners to utilize 20,000 cu. ft. of water per sec. from the head of Whirlpool Rapids for the operation of a power plant at this location. Plans for the hydroelectric plant are now being drawn.

Buffalo, N. Y.—The Niagara Falls Power Co. has received permission from the Federal Water Power Commission to utilize 19,500 cu. ft. of water per sec. from the Niagara river, above the falls, for increased power generation. Under the terms of the agreement the company will make extensions in its hydroelectric plants to increase the output from 300,000 to 400,000 hp. The company will also build additions in its transmission and distributing lines from Grand Island to Buffalo, which will comprise a new high-tension line, and to points to supply power to the Niagara, Lockport & Ontario Co., now securing its power from a Canadian source. Paul A. Schoellkopf is president.

Corning, N. Y.—The Corning Glass Works has plans under way for the construction of an electric power plant at its works to cost about $250,000. Dwight P. Robinson & Co, 125 East 46th street, New York City, is engineer.

Grahamsville, N. Y.—The Ulster-Sullivan Electric Light & Power Co. has been incorporated with a capital of $40,000 to operate a local electric light and power system, with transmission lines to reach different municipalities in Sullivan and Ulster counties. The incorporators are S. W. Krum, R. Tompkins and W. Briggs, Jr., Grahamsville.

Medina, N. Y.—The Western New York Utilities Co. has plans under way for the construction of its proposed hydroelectric power plant in this section. A. L. Sweet is president.

New York, N. Y.—The New York Edison Co. has received the contract for the electrical installation in the 9-story annex now being erected at the Baker & Williams warehouse at Greenwich and LeRoy streets. It will consist of 960 lamps and 100 hp. for the operation of elevators and pumps. The entire installation at the works will be 1160 lamps and 273 hp.

New York, N. Y.—The Petrogras Corp. has been incorporated with a capital of $500,000 to construct and operate an electric light and power plant. The incorporators are L. J. Goodman, F. Marston and S. Luger, 210 West 80th street.

New York, N. Y.—The New York Central Railroad Co. will soon take bids for the erection of its proposed electric substation at Park avenue and 110th street, to be 1-story, 50 by 57 ft., and estimated to cost $25,000. Albert F. Holdeman, Grand Central Terminal, is architect.

New York, N. Y.—The Automatic Light & Power Corp. has been incorporated with a capital of $108,000 to operate a light and power system in this vicinity. R. M. Owen, 1851 Broadway, is the principal incorporator.

New York, N. Y.—The Central Catskill Light & Power Co. has been incorporated with a capital of $50,000 to operate an electric light and power system in Ulster and Delaware counties. The incorporators are D. and J. J. Sameth, J. Hollander, 601 West 184th street.

Rossie, N. Y.—The Rossie Electric & Manufacturing Corp. has made application to the Public Service Commission for permission to build electric light and power plants at Rossie and Hammond, and for approval of franchises granted in this district.

Troy, N. Y.—Henry Ford, Detroit, has been granted permission by the Federal Water Power Commission to utilize waters at the government dam at Green Island, near Troy, for his proposed hydroelectric power plant. The station will cost about $2,500,000 with machinery, and will be used in connection with a new tractor manufacturing plant to cost about $7,500,000. Stone & Webster, 147 Milk street, Boston, are engineers for the power project.

Tupper Lake, N. Y.—The Lawrence Transmission Co. will erect a transmission line at a cost of $30,000. Address F. A. Stoughton, president, Potsdam, N. Y.

Wappingers Falls, N. Y.—The New York State Public Service Commission has granted authority to the Wappingers Electric Corp. to construct an electric light plant and give service to the local community.

Watertown, N. Y.—The Remington Paper & Power Co. has filed notice of change of name to the Hanna Paper Co., at the same time increasing its stock from $800,000 to $2,500,000. The change will not affect company operations, and power plants will be maintained as heretofore. Expansion is planned.

Atlantic City, N. J.—The Atlantic City Electric Co., Arnold Building, has preliminary plans under way for extensions and improvements in its electric generating plant to cost about $500,000, including new machinery.

Edgewater, N. J.—The Luckenbach Steamship Co., 44 Whitehall street, New York City, will install considerable electrical and mechanical equipment in connection with its proposed freight terminal here, comprising cranes, hoisting apparatus, loading and unloading machinery, conveying machinery, etc.

Newark, N. J.—The International Coal Products Co., Irvington, Newark, is negotiating with the Irvington Town Council for permission to rebuild its power plant, recently destroyed by fire, as well as one primary oven, also destroyed at its local fuel briquette plant. The fire loss is estimated at $100,000.

Perth Amboy, N. J.—A power plant will be erected by the Burnrite Coal Briquette Co., 543 New Jersey Railroad avenue, Newark, N. J., in connection with its new plant at Perth Amboy. Conveying and hoisting machinery, electrically operated, will be installed at the plant, and other departments will be electrically operated.

South River, N. J.—The State Supreme Court has handed down a decision setting aside a resolution adopted by the borough council for an expenditure of $206,889 for extensions and improvements in the municipal electric power plant. Contracts awarded for the work have also been vacated. The court holds that under the act of 1917, an ordinance authorizing a sufficient appropriation is required before entering into any contract by a municipality in the state, the cost of which is to be financed by

bonds or notes. The court says that although the resolutions were adopted by the borough, no ordinance was passed, and that this neglect was fatal. The borough council, it is said, will proceed to arrange the proposition in the correct way as pointed out by the court.

Wilmington, Del. — The Bowers Beach Corp., recently organized, will install an electric-lighting system and other electrical equipment in connection with the development of Bowers Beach into a pleasure resort. W. H. Durborough is president, and Edward J. Welsh, secretary and treasurer.

Chester, Pa.—The Delaware County Electric Co. has awarded a contract to H. Louis Morris, Pennsylvania Bank building, for the rebuilding of its 2-story building at Front and Market streets, recently destroyed by fire.

Hamburg, Pa. — The Greenwich Electric Co. has been organized with a nominal capital of $5000, to operate a local light and power system. H. R. Shollenberger is treasurer.

Mount Wolf, Pa.—The Borough Council is arranging for the installation of a number of new street lamps.

Philadelphia, Pa.—William S. Diamond has filed plans for extensions and improvements in the power house at his factory at Tulip and Westmoreland streets.

Philadelphia, Pa.—The Department of City Transit has taken bids for the construction of an electric substation at Front street and Fairmount avenue for use in connection with the Frankford elevated railway, and will soon award the contract. Contract has been let to Franklin M. Harris & Co., 1518 Prairie street, for the new inspection shops for the line on Pennsylvania avenue, near Bridge street, in which considerable electrical equipment will be installed. The shops will cost about $150,000.

Pittsburgh, Pa.—The Pittsburgh-Beaver Light Co. has made application to the Public Service Commission for approval of a franchise granted by the Township of Leets. The company has secured a contract for lighting the streets and highways for a period of 3 yrs., covering all sections of the township.

Pottsville, Pa.—The Pennsylvania Light, Heat & Power Co. has secured a mortgage from the Guaranty Trust Co., New York City, for $12,239,600, covering its property in Columbia, Montour, Northumberland, Schuylkill, Luzerne, Carbon, Lehigh, Northampton and Berks counties. The company has made application to the Public Service Commission to issue bonds for $190,000.

Reading, Pa. — The Metropolitan Edison Co. has filed application with the Public Service Commission for permission to issue bonds for $43,000, the proceeds to be used for operations, etc.

Steelton, Pa.—The Borough Council has plans under way for the installation of electric equipment at the filter plant of the local waterworks.

Topton, Pa. — The Weisenberg Township Electric Light & Power Co. has been organized with a nominal capital of $5000 to install and operate a light and power system in this section. D. S. Martin, Reading, Pa., is treasurer.

Uniontown, Pa.—The board of directors of the Uniontown Hospital will take bids at once for the erection of a power house at the institution in connection with a new laundry and garage.

Williamsport, Pa.—The Lycoming Edison Co. has made application to the Public Service Commission for permission to issue notes for $117,000, the proceeds to be used for extensions, operations, etc.

York, Pa.—Walter A. Dromgold and associates are arranging for the erection of a hydroelectric generating plant at Marsh Run, near York Haven, on the Susquehanna. A site has been acquired and necessary water rights secured. The initial plant will have a capacity of close to 90,000 hp.

Baltimore, Md.—The Public Improvement Loan Commission has approved plans for the erection of a pumping plant at the Black River disposal plant, electrically operated, to cost about $11,000.

Baltimore, Md.—The Consolidated Gas, Electric Light & Power Co., Lexington building, has been ordered to install all wires underground in the district bounded by Fort avenue, Winder, Light and Charles streets prior to July 25. The Electrical Commission of the city has jurisdiction over the territory.

Baltimore, Md.—The Wizard Check Indorser & Printing Machine Co., Calvert building, will call for bids at an early date for the erection of a power plant and factory at Highlandtown, estimated to cost $300,000. The company has arranged for an increase in capital from $500,000 to $3,000,000 for expansion. F. S. Weise is president.

Chestertown, Md. — The Chestertown Electric Co. has been ordered by the Public Service Commission to continue the operation of its local plant, pending the outcome of a controversy regarding a new contract for lighting with the municipality. The company has asked an advance in rate and the borough officials have declined to approve the contract.

Rockville, Md.—The local power plant was slightly damaged by fire recently, with a loss estimated at $1000.

Williamsport, Md.—The W. D. Byron Co. has plans under way for the erection of 1-story power plant at its local leather works to cost about $50,000. Walter Byron is head. Quigley Hafer, 155 Garfield street, Chambersburg, Pa., is architect.

Bristol, Va.—The Electric Transmission Co. of Virginia is planning a number of extensions in its system, including betterments in present lines. The company has increased its capital from $500,000 to $1,200,000.

St. Albans, W. Va.—The St. Albans Light, Water & Ice Co. will extend its waterworks and construct a 1,500,000-gal. filter plant at a cost of $75,000. Address H. K. Bell, engineer, Lexington, Ky.

Mount Olive, N. C.—The Borough Council has approved a bond issue of $30,000 for the purchase of the local electric-lighting system. Extensions will be made upon acquisition. T. R. Thigpen is clerk.

Greer, S. C.—The City Council is completing plans for the construction of an electric transmission system to cost about $100,000, with local distributing lines. The high-tension system will connect with the plant of the Blue Bidge Power Co., from which source power will be received for city service. W. N. Willis is engineer.

Cordele, Ga.—The city council is arranging a bond issue of $40,000 for the erection of a municipal electric light and power plant. J. Gordon Jones is mayor; W. G. Webb is engineer.

Tilton, Ga.—The Southern Water Power Co., recently organized, is planning the operation of a hydroelectric power plant in this section. John Pope and L. P. Thurman head the company.

NORTH CENTRAL STATES.

Grand Haven, Mich.—The Beech Tree Light & Power Co. has been granted permission to use the highway right-of-way for the erection of the necessary poles for the construction of its power and light lines.

Ravenna, Mich.—Plans have been prepared by Holland, Akerman & Holland, engineers, 106 East Liberty avenue, Ann Arbor, Mich., for the erection of a $70,000 hydroelectric power plant. Address T. Rogers, Ravenna-Conklin Electric Light & Power Co.

St. Joseph, Mich.—In connection with the proposed curb-lighting system, a committee has been appointed by Mayor Herman O. Balow with instructions to investigate the present lighting system and the proposals of the chamber of commerce and the board of public works.

Hammond, Ind.—W. F. Bridge, engineer, City Hall, has prepared plans for a boulevard lighting system. Address A. J. Swanson, chairman.

Kendallville, Ind.—Plans have been prepared by Froehlich & Elnery, engineers, 403 Second National Bank building, Toledo, O., for the erection of an addition to the power plant and boiler house at a cost of $102,450. Address S. E. Dickenson, general superintendent.

South Elgin, Ill.—The city will vote April 19 on the question of issuing $5,000 in bonds for the purchase of equipment to light its streets. Address Frank A. McCarthy, attorney.

Taylorville, Ill.—Work on the municipal lighting plant is expected to begin April 1, the $80,000 in bonds having been sold to two Chicago bond houses. The city council will advertise for bids for the erection of the plant shortly.

Waukegan, Ill.—The city engineer has been instructed to prepare a new set of plans for the various kinds of ornamental lighting posts. Address Carl Atterbery, commissioner.

LaCrosse, Wis.—The City Mills Co., recently organized, has purchased the City Mills and will install electrically operated equipment.

Clarinda, Ia.—The Community Club will urge the city council to take steps toward the establishment of a municipal light and power plant. Address Dr. C. B. Eller, chairman.

Fulton, Mo.—It is planned to make repairs to the municipal lighting plant. Address city clerk.

Marshall, Mo.—The Missouri Gas & Electric Co. plans improvements and extensions to its electric power plant at an estimated cost of $75,000.

Warrensburg, Mo.—It is planned to vote on the question of issuing $150,000 power-plant bonds. Address F. L. Wilcox, engineer, Chemical building, St. Louis.

Warrensburg, Mo.—The proposed municipal lighting plant for this city will cost $181,000, according to figures submitted to the council by Engineer Frank Wilcox, St. Louis, who reports that the plant would cost an additional $50,000 if it is erected at Bristle Ridge, where the structure would be in a coalfield.

Wheaton, Mo.—The Wheaton Ice, Light & Cold Storage Co., recently organized, has plans under way for the construction of an electric light and power plant. An ice-manufacturing plant will be operated in conjunction. H. C. Hindman is manager.

Morganville, Kan.—Plans have been prepared by W. B. Rollins & Co., engineer, 209 Railway Exchange building, Kansas City, Mo., for the construction of a transmission line and city distribution system. Address C. E. Huff, city clerk.

Fargo, N. D.—Bonds will be voted on in April for a municipal lighting plant. C. V. Smith, secretary of the Trades and Labor Assembly, is interested in the proposition.

SOUTH CENTRAL STATES.

Greenup, Ky.—Plans have been prepared for the erection of a $50,000 power house. Address Col. W. P. Stickey, room 513, Government building, Cincinnati.

Paducah, Ky.—The Paducah Electric Co. is planning extensions and improvements in its system to cost about $250,000. The company's generating plant will also be enlarged and improved, and new machinery installed.

Dothan, Ala.—The city council has arranged for a bond issue of $750,000 for the purpose of erecting a hydroelectric plant on the Choctawatchee river. Address R. W. Lisenby, city clerk.

Pascagoula, Miss.—It has been voted to purchase light and water plants. Address the mayor.

Lake Arthur, La.—Bonds to the amount of $50,000 have been voted to install an electric light plant. Address the mayor.

Rogers, Ark.—The Rogers Power Co., recently organized, will operate a local light and power system. E. G. Sharp and Morgan McMichael head the company.

Skiatook, Okla.—Charles Page plans to install a lighting system at this place.

Electra, Tex.—The Gladiolus Oil Co. will rebuild its power house which was recently destroyed by fire, with a loss of $10,000.

Fredericksburg, Tex.—A portion of the electric light and power plant of Ernest Wilke & Co. was destroyed by fire recently, causing a loss of $35,000.

Fort Worth, Tex.—The Fort Worth Power & Light Co. is planning extensions and improvements in its system. The company has increased its capital to $276,000. A. J. Duncan is president and manager.

Temple, Tex.—The city may install its own electric plant in connection with the waterworks, plans for which are now being considered. Address city clerk.

WESTERN STATES.

Blewett, Wash.—The Amalgamated Gold Mines Co. will build a $50,000 hydroelectric plant here. Address C. R. Heseltine, president.

Tacoma, Wash.—Bids will be received March 24 for installing a street-lighting system in district No. 5515. Address Ira S. Davidson, commissioner of light and water.

Walla Walla, Wash.—Plans are being prepared by the city commissioners for the city to own its street-lighting system. It is proposed to create assessment districts and install an entire new system of lamps to replace arcs in the residence district.

Bandon, Ore.—An election was held March 8 to vote on the question of constructing a power system and the installing of the necessary apparatus to equip it for furnishing light and power for the city. It is planned to construct a hydroelectric plant on Willow creek, about 20 mi. south of Bandon, a transmission line, etc. The estimated cost of the project is $110,000.

Salem, Ore.—The State Board of Control has awarded a contract to the Salem Electric Co. for supplying electric lamps for all the state buildings.

Hollywood, Cal.—Bonds will be voted shortly to install a lighting system at a cost of $1,250,000. Address E. F. Scatergood, engineer.

Los Angeles, Cal.—The Los Angeles Gas & Electric Corp. has applied for permission to issue $2,000,000 of its preferred stock for the purpose of improving and extending its lines. Address William Baurhyte, vice-president.

Marysville, Cal.—Plans have been prepared by the Excelsior Water & Milling Co., of which C. F. Ayer is president, for hydroelectric power developments and to furnish water sufficient to irrigate 125,000 acres of land in Yuba, Sutter and Nevada counties. The total cost of the project is estimated at $25,000,000.

Sacramento, Cal.—The Southern Pacific Co. will build a power plant. Address J. H. Dyer, general manager, San Francisco.

San Francisco, Cal.—The Pacific Gas & Electric Co. has applied for permission to issue $3,000,000 first preferred stock. The proceeds are to be used to reimburse the company's treasury for plant development and to pay for part of construction work on hydroelectric projects now under way.

Monterey, Mexico.—The Dolores Mines Co., an American corporation, plans to construct an electric power plant at Madera, State of Chihuahua, and to build an ore reduction mill at Dolores. The proposed improvements are estimated to cost $750,000.

CANADA.

Niagara Falls, Ont.—The Hydroelectric Power Co., is arranging for the immediate installation of two 55,000-hp. generating units at its power plant on the Cippewa-Queenstown power canal, and proposes to have the work completed, with all auxiliary operating machinery, early in the fall.

Quebec, Que. — Considerable electrical and mechanical equipment was recently destroyed by fire at the service buildings of the Levis County Electrical Railway Co., with loss estimated at $300,000.

PROPOSAL.

Tacoma, Wash.—Bids will be received March 24 for furnishing labor, material and tools for installing a street-lighting system in district No. 5515. Address Light and Water Commissioners, 402 City Hall.

INCORPORATIONS

Rochester, N. Y.—Pomeroy Electric Co. Capital $40,000. To manufacture electrical equipment. Incorporators: S. S. R. Robinson, H. N. Bennett and B. H. Pomeroy.

New York, N. Y.—Allied Electrical Dealers, Inc. Capital $1,000,000. To manufacture and deal in electrical machinery and supplies. Incorporators: John J. Garrison, F. G. Haag and Ludlow S. Fowler.

Trenton, N. J.—Bertrand F. Miller Co., Inc. Capital $25,000. To manufacture electrical supplies. Incorporators: N. F. House, Clifford M. and Bertrand F. Miller.

Hoboken, N. J.—Electro Service Co., Inc. Capital $5000. To manufacture and deal in electrical equipment and supplies. Incorporators: Ernest and Albert J. Casper, 413 Jane street.

Dallas, Tex. — Continental Radio Telegraph Co. Capital $100,000. Incorporators: W. H. Fields and others.

Chicago, Ill.—Co-operative Manufacturing Co. Capital, $2000. To manufacture electric motors, etc. Incorporators: C. E. Cossiboin, L. J. Zanda and A. R. Blaski, 1867 Milwaukee avenue.

Montreal, Que.—Supercharge Engine Co. of Canada, Ltd. Capital, $2,000,000. To manufacture motors, engines, machinery, etc. Incorporators: Joseph Demers, Joseph A. Choquette and others.

New York, N. Y.—Porter Electric Carburetor Co. Capital, $300,000. To manufacture carburetors and ignition equipment. Incorporators: A. W. Porter, 126 West 36th street; F. B. Skinner and F. W. Skinner.

New York, N. Y.—Carnahan & Dalzell, Inc. Capital, $20,000. To manufacture electrical machinery. Incorporators: R. O. Carnahan, B. Gunn and R. N. Dalzell, Great Kills, Staten Island.

New York, N. Y.—Lighthouse Corp. Capital, $50,000. To manufacture lighting fixtures. Incorporators: B. Newland, 468 West Broadway, and others.

Elizabeth, N. J.—Hunter Brothers, Inc. Capital, $50,000. To manufacture electrical appliances. Incorporators: James F. Hunter, 334 Morris avenue, and others.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Offering of Northern States Power Co. Bonds.

H. M. Byllesby & Co., Harris Trust & Savings Bank and Bonbright & Co. are offering $1,000,000 first and refunding mortgage 6% bonds of the Northern States Power Co., due April 1, 1941, at a price to yield over 7%. The proceeds will be used for extension and improvements to the properties of the company. Earnings are reported in excess of two and one-third times the annual bond interest charges of the company including this issue.

Arkansas Light & Power Co.

	1920.	1919.
December gross	$ 93,279	$ 64,369
Net after taxes	17,508	14,666
Total income	18,913	16,909
Twelve months' gross	1,201,923	809,700
Net after taxes	231,471	192,904
Total income	274,460	205,132
Surplus after interest charges	134,060	83,045
Balance after preferred dividends	38,890	4,804

Bond Offering of California-Oregon Power Co.

A new issue of $2,000,000 of the California-Oregon Power Co. first and refunding mortgage sinking fund 7.5% 20-year gold bonds, series "A," is being offered at par and interest by the Harris Trust & Savings Bank, Chicago.

Duquesne Light Co. Earnings.

The Duquesne Light Co., Pittsburgh, has issued a statement showing gross earnings during the past year of $1,553,084, an increase of $263,577 over the previous year. The net after taxes, etc., is $547,104, an increase of $70,212 over the preceding period.

Manufacturers' Light & Heat Co.

For the year ended Dec. 31, 1920, gross was $12,095,133, increase of $1,107,594; net after taxes, $2,509,049, decrease $1,427,946; total income $2,598,638, increase $1,428,659; surplus after charges $2,553,574, decrease $7,097; dividends paid $1,840,000, decrease $460,000; surplus after dividends $713,574, increase $452,903; profit and loss surplus $9,691,080, increase $713,574.

Sayre Electric Co.

	1920.	1919.
December operating revenues	$19,044.57	$12,922.49
Operating expenses, taxes and rentals	15,699.87	10,109.05
Operating income	$ 3,344.70	$ 2,813.44
Amount of maintenance expenditures included in above operating expenses	$ 1,580.87	$ 751.65

Binghamton Light, Heat & Power Co.

	1920.	1919.
December operating revenues	$77,315.07	$51,607.28
Operating expenses and taxes	51,390.14	33,209.41
Operating income	$25,924.93	$18,397.87
Amount of maintenance expenditures included in above operating expenses	$ 8,252.02	$ 3,194.94

Louisville Gas & Electric Co.

Comparative earnings of the Louisville Gas & Electric Co. for the years ended Jan. 31, 1921, and 1920, are reported as follows:

	1921.	1920.
Gross earnings	$4,588,330	$3,651,449
Net earnings	2,116,326	1,854,409

Republic Railway & Light Co. and Subsidiaries.

	1920.	1919.
December gross	$ 766,646	$ 647,548
Net after taxes	194,198	185,956
Total income	183,686	176,943
*Surplus after charges	23,353	66,463
Twelve months' gross	8,304,549	6,259,612
Net after taxes	1,906,800	1,572,664
Total income	2,014,768	1,772,363
*Surplus after charges	481,155	463,462

*Before depreciation.

North American Light & Power Co.

Report for the year ended Dec. 31, 1920, shows surplus after charges and taxes of $192,823, nearly three times the preferred dividend charges, which compares with a surplus of $68,313, or about twice the preferred dividends in the preceding year. Income account follows:

	1920.	1919.
Gross operating revenue	$2,769,552	$1,727,832
Operating expenses and taxes	2,036,387	1,230,041
Net operating revenue	733,165	497,791
Interest, dividends, etc.	241,870	126,998
Balance	491,295	370,793
Other income	57,330	1,980
Total income	548,625	372,772
Interest, depreciation, etc.	355,802	304,460
Preferred dividends	66,979	36,174
Surplus	125,844	32,139

Rutland Railway Light & Power Co.

	1920.	1919.
December operating revenues	$52,013.30	$46,987.53
Operating expenses and taxes	43,823.97	37,037.50
Operating income	$ 8,189.33	$ 9,950.03
Amount of maintenance expenditures included in above operating expenses	$11,022.52	$11,425.46

Telephone Company Plans New Issue of Stock.

The New York Telephone Co., 15 Dey street, New York City, is considering tentative plans for a security issue to total about $33,600,000, the proceeds to be used in part for necessary extensions and improvements to plants and system. The work will include completion of exchange buildings now in course of erection, and a number of new structures of this kind, lines, etc.

Virginia Railway & Power Co.

	1921.	1920.
January gross	$1,018,819	$833,433
Net after taxes	304,324	348,799
Total income	315,843	359,972
Surplus after charges	111,963	116,182

Note.—Six per cent of gross for depreciation was charged off in operating expenses in 1921 and in charges in 1920.

Mississippi River Power Co.

	1920.	1919
December gross earnings	$ 249,131	$ 206,284
Net earnings	172,587	160,651
Surplus after charges	70,148	58,887
For calendar year—		
Gross earnings	2,735,371	2,321,954
Net earnings	2,096,748	1,799,325
Surplus after charges	981,086	568,590

Dividends.

	Term.	Rate.	Payable.
Allis-Chalmers, com.	Q	1%	May 16
Allis-Chalmers, pfd.	Q	1.75%	Apr. 15
Buffalo Gen. El., com.	Q	2%	Mar. 31
Can. Gen. El., com.	Q	2%	Apr. 1
Cent. States El., pfd.	Q	1.75%	Apr. 1
Can. Gen. El., pfd.	Q	3.5%	Apr. 1
Emer. El. Mfg., pfd.	Q	1.75%	Apr. 1
Mfrs. Lt. & Heat	Q	2%	Apr. 15
Miss. River Pr., pfd.	Ini.	1.5%	Apr. 1
Niagara Falls Pr., pfd.	Q	1.75%	Apr. 15
United Lt. & Rys., 1st pfd	Q	1.5%	Apr. 1
Western Un. Tel.	Q	1.75%	Apr. 15

WEEKLY COMPARISON OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller & Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate. Per cent.	Bid Mar. 8.	Bid Mar. 15.
Adirondack Electric Power of Glens Falls, common	6	13	12
Adirondack Electric Power of Glens Falls, preferred	6	71	71
American Gas & Electric of New York, common	..	103	101
American Gas & Electric of New York, preferred	6	37	36½
American Light & Traction of New York, common	..	108	101
American Light & Traction of New York, preferred	6	82	81
American Power & Light of New York, common	4	48	50
American Power & Light of New York, preferred	6	65	67
American Public Utilities of Grand Rapids, common	..	7	8
American Public Utilities of Grand Rapids, preferred	7	17	18
American Telephone & Telegraph of New York	..	102	101
American Water Works & Elec. of New York, common	..	3½	3½
American Water Works & Elec. of New York, particip	7	6½	6½
American Water Works & Elec. of New York, 1st preferred	..	39	41
Appalachian Power, common	..	3	3
Appalachian Power, preferred	7	23	24
Cities Service of New York, common	+extra	235	230
Cities Service of New York, preferred	6	67	67
Commonwealth Edison of Chicago	8	107	107
Comm. Power Railway & Light of Jackson, common	..	13	13
Comm. Power, Railway & Light of Jackson, preferred	6	33	33
Federal Light & Traction of New York, common	..	6½	6½
Federal Light & Traction of New York, preferred	..	41	42
Northern States Power of Chicago, common	..	48	46
Northern States Power of Chicago, preferred	ex.div.7	79	79
Pacific Gas & Electric of San Francisco, common	..	47	47
Public Service of Northern Illinois, Chicago, common	7	75	76
Public Service of Northern Illinois, Chicago, preferred	6	82	82
Standard Gas & Electric of Chicago, common	..	11½	11
Standard Gas & Electric of Chicago, preferred	8	35	34
Tennessee Railway, Light & Power of Chattanooga, common	..	1½	1
Tennessee Railway, Light & Power of Chattanooga, preferred	6	4½	5½
Western Power of San Francisco, common	..	25	25
Western Union Telegraph of New York	..	87	87
Industrials—			
Electric Storage Battery of Philadelphia, common	4	98	98
General Electric of Schenectady	8	132	128
Westinghouse Electric & Mfg. of Pittsburgh, common	7	47	47